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and  
**Oral Surgery**

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# International Journal of Orthodontia and Oral Surgery

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# International Journal of Orthodontia and Oral Surgery

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VOL. 22

JULY, 1936

No. 7

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## Orthodontia

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### PRESIDENT'S ADDRESS

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SOUTHWESTERN SOCIETY OF ORTHODONTISTS

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LOUIS S. WINSTON, A.B., D.D.S., HOUSTON, TEXAS

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I AM temporarily the leader of the organized efforts of an important branch of our great profession. The election of a man to the presidency of this society should be viewed in no light other than as an opportunity and challenge for service. There is or should be expected of the president, first, that with the aid of the other officers and of every member, he give a good annual meeting, and, second, that through the opportunities afforded by the office, he make some lasting contribution to the growth of the Southwestern Society and to the interests of orthodontia in general. When a man accepts the office, he accepts the challenge and in effect says, "Fellows, this is a big responsibility, perhaps too big for my shoulders, but I appreciate the compliment, and am going to strive my level best to measure up to your expectations."

I want to say a word in praise of the Southwestern and its sister organizations. So highly do I value my society connections that since my graduation from the Dewey school in 1923, I have missed no meeting of this society, and only one of the American Society of Orthodontists, the one held in Canada. As valuable as have been postgraduate courses and experience to me in my work, I do not believe they have exceeded in value the society meetings. They are a continuous postgraduate course, bringing to us the experience of others.

I deplore the attitude of many of the older men—of slighting the society meetings or cutting them altogether. As you grow older, the meetings mean less to you on the learning end, but more on the teaching end. Every orthodontist worthy the name has some ideas which will help the rest of us. A broad

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Meeting held in Houston, Texas, October 31, November 1 and 2, 1935.

interpretation of ethics demands we be our brother's teacher. Those who need these remarks most are probably not present. I can only warn those here, especially the new members, not to fall into such ways. Make every meeting, even if you have to borrow the money, and bring along some contribution to the program of the Southwestern every year.

Not the least value of our meetings is the fellowship with friends who grow dearer as the years go by. I think I shall always regard the men of the Southwestern as the finest group it has ever been my privilege to be associated with.

It is customary for the president to advocate some measures designed to improve our manner of carrying on society business. While doing so it is superfluous for me to point out to our alert membership that giving thought to such matters is equally incumbent upon each member, and to make recommendations is equally the privilege of each.

Our society has increased greatly in size since its organization in 1920 when, I presume, the general plan of its constitution and By-laws, as still in use, was laid out. While revision of those documents to conform with the contemplated reorganization of the American Society of Orthodontists is a possibility of the next few years, still there are some changes which would be advantageous immediately and whether or not the American Society of Orthodontists is reorganized. Consequently I have appointed a committee on revision of the constitution consisting of H. H. Sorrels, chairman, T. W. Sorrels, P. G. Spencer, Brooks Bell, Flesher, and myself. Flesher, Bell, and T. W. Sorrels are already members of the reorganization committee for the American Society from this district.

In our constitution, at the close of Art. V., Sec. 1, occurs the sentence, "The elective officers shall constitute the Executive Board." Nothing is said in the constitution or By-laws concerning meetings of this board or what authority it possesses to transact business for the society. It has become the practice in recent years for the president to call a meeting of the Executive Board in Dallas, several months before the annual society meeting, to decide the date and to outline the program for such meeting. The present board met at the call of the president in Dallas on June 30, 1935. Having known nothing in advance of the probable date of this board meeting, two of its members were away on extended vacations and were unable to attend. The Board felt somewhat constrained by the lack of any constitutional provision granting it any power.

I therefore recommended the following amendment to the By-laws: "Art. I, Sec. 5, Meetings, Duties, and Authority of Executive Board. The Executive Board shall meet annually, at intervals of approximately six months from the society meetings, at a place of central location in the Southwestern district, the exact time and place to be designated by the president at least two weeks in advance. Special meetings may also be called by the president. Besides determining the general outline of the program of the next society meeting and giving instructions thereon to the Board of Censors, it shall be the duty of the Executive Board to transact all business and to act on all matters not specifically delegated by the constitution or By-laws to officers, committees, or the society

as a whole. Matters which it sees fit the Board shall refer to the society as a whole for action. Authority is granted by this section to the Executive Board to act for the society in all matters covered herein, and contracts made by it, moneys spent and contracted to be spent shall be binding upon the society. Each member of the Executive Board shall be allowed his actual expenses for attendance on each board meeting, regular or called." By-laws, Art. I, Sections 5 and 6 to be changed to Sections 6 and 7 respectively.

I submit the above amendment in detail as that is the simplest method of putting before you all my ideas pertaining to it. I request of the amendment committee that they either endorse it or offer a substitute.

I suggest that at a business session of this meeting, there be held a general discussion, directed toward adoption of a uniform procedure in transferring patients, at least among our members. Patients are frequently transferred with little or no information as to history of the case, contract, financial status, and payment record. Furthermore, when we permanently transfer a case, have we a right to retain models or x-ray pictures, unless duplicates? What about our file of appliances constructed for the case, not in use at time of transfer but which may be needed again? When a case is transferred with a balance due on the contract, should the orthodontist accepting the case see that that is paid before keeping any money for himself?

One receiving a transferred case is at liberty to make his own contract, charging an initial fee if he deems fit; however, out of consideration for the patient, I usually try to complete at the original contract, and usually lose by doing so. This loss I am glad to take because it makes for good will toward the profession.

The adoption of stainless steel or chrome alloys in appliance construction by a small number of men has injected a new difficulty into the transfer of patients. No one would choose to transfer a patient to a man who is going to remove all appliances and put on a new set. We need a new directory of orthodontists, differentiating those who are sticking to the precious metals from those who have gone over to the cheaper base alloys. You can put me down on the list of those who are still on the gold standard.

It has been a matter of the greatest pride among us in the past that not only were the men of the Southwestern almost without exception the finest fellows in the world, but that with an equal degree of unanimity they saw alike and agreed in principles of treatment and choice of appliances. But we are growing, and times are changing, and I am unable to say whether that record is worth striving to retain, or whether we could retain it if we tried.

It is a function of all official gatherings of this kind to consider questions pertaining to the present status and the future of the profession and its relations with the public.

To enable us better to understand our present problems, allow me briefly to refer to the nature of the problems which have confronted the profession in the past.

The past development of orthodontia may be divided into two steps or phases, viz., mechanical and biological.

In its beginnings the science was confined to the adaptation, often crudely and cruelly, of the various mechanical principles and devices which have existed from the earliest time, to the task of moving teeth. With the working out of tough, elastic alloys of precious metals, compact, comfortable appliances were brought to their present degree of efficiency by shortly after 1920. If we mention Angle and Mershon as outstanding figures of this period, it is not with any desire to dismiss, without giving due credit, the work of dozens of others, before and after 1900. No scientific discovery is ever entirely original, but the man who completes it stands on the shoulders of those before him. For example, Marconi's work was dependent upon that of Faraday, Benjamin Franklin, and many others. Incidentally, this thought should make us hesitant about attaching our name to any device which we may perfect.

Before the mechanical stage of development reached its height, indeed aiding in popularizing the lighter mechanisms of delicate pressure, came the group of men who conceived of orthodontics as a mechanobiologic problem. They taught us to consider the teeth not as a unit in themselves, but as a part of the body as a whole. This group is large and is still being added to. It includes Dewey, Ottolengui, Howard, Johnson, Lundström, and Marshall. We are still in the biologic stage, and much will no doubt be added to our knowledge of biologic facts in the next few years. Perhaps Dr. Johnson will tell us that our knowledge of etiology and diagnosis are far from the requirements for carrying on intelligent treatment. Nevertheless our mechanical and biologic problems are far eclipsed in urgency today by those of supply and distribution.

Overlapping then the biologic stage, we are now entering a third or social stage. Indeed, a social problem has never been lacking to orthodontia, but has been one of steady growth and is far more acute today than ever before.

Thinkers tell us that there exists in this country a great disturbance of the public mind relating to all social problems, and transitions are in progress which may affect the whole organization of society. I believe the American people are too firmly anchored in certain fundamental beliefs ever to adopt communism or radical socialism, but recently we have seen national policies adopted that approach socialism, and there are probably others to follow.

The basis for the social problem in orthodontia lies in the fact that at present, counting the work of all agencies good and bad, only about one per cent of the serious malocclusions in this country are receiving any kind of treatment. This constitutes for us a real problem, regardless of any general unrest of the public mind.

Universal orthodontic care, even in this wonderful land of opportunity, is an unattainable ideal. There is, however, an obligation upon us, which the leaders of the profession are beginning to recognize, to extend orthodontic service to a far wider segment of society.

The recognition of such an obligation is evidenced by the fact that both Dr. Waugh and Dr. Casto, as presidents of the American Society of Orthodontists and American Dental Association respectively, have discussed the subject in addresses, and much is being written about it in the dental journals.

The surest way to prevent outside regulation of our profession is to have it well regulated from within. If it becomes apparent that we are affording

treatment to as large a number as can be reasonably expected, that the number is constantly increasing at a good rate, and that those we serve are usually well pleased, well and good for us; we may be allowed to direct the profession's future growth.

But the problem of supplying orthodontic service always has been and always will be complicated by the necessarily considerable cost of the work. It was natural in the beginning, due to the great scarcity of supply, that the work should be high in price and confined to those able to pay well for it. For many years fees were "all that the traffic would bear." Ours was called a "luxurious specialty." But the specialty is now thirty-five years old: the number of men versed in it has continued to grow, and the public, or rather the intelligent part of it, has been educated to have confidence in us. The demand is enormously increased, but contingent in most instances upon a radical reduction of fees.

I should say that the demand of today is that orthodontia be placed within the reach of every family of average means. Is it too much to suggest as the aim of all orthodontists and all orthodontia societies, the supplying of that demand within this generation or the next thirty-five years?

I propose for the Southwestern Society, the aim "Orthodontia available to every family of average means in our territory by 1970"; 1970 seems a long way off. Maybe we can accomplish it sooner. I hope to live long enough to see it an accomplished fact, as many here present no doubt will.

I have reread the purpose of this society as contained in our constitution, and there is nothing there to compare with this in vital appeal. It has been pointed out that the basic tenets of our Christian (in the broadest sense) civilization are the capacity for voluntary individual action and service to others. If these tenets go, our civilization goes, and we shall have communism or something else. Here is our great opportunity to express these tenets in our activities.

I do not believe that the term "average means" or "average income" requires discussion here. Figures are available, but probably mean little. The average varies in different communities, and each of us has a pretty fair idea what it is in our community.

The effort is being made to supply the demand for great quantities of cheap orthodontia by certain general practitioners of dentistry. What they are offering is not the real thing at all, but a shoddy substitute. Dr. Waugh tells us: "A fairly recent survey has shown that approximately twenty thousand dentists are doing some corrective orthodontics, or, perhaps much better said, attempting the straightening of teeth. About 6 per cent of these stated that they had studied orthodontics after leaving the dental school, which means that eighteen thousand eight hundred dentists admitted that without preparation beyond that received in the undergraduate course they are attempting a service for which they were not prepared, as no dental school has ever claimed to qualify all its undergraduates for the practice of orthodontics."

It is my conviction that orthodontia can be done in a creditable way, as a general thing, only by those who confine their efforts to this specialty alone. I have tried to think, because of the great numbers of children in rural districts and in small communities lacking access to orthodontists, that it could be worked for local or nearby general dentists to handle such cases. But the more I learn of

the problems involved in orthodontic diagnosis and treatment, the more convinced I am that it cannot be done and should not be attempted. No one but a specialist should attempt a case of orthodontia. Isolated examples of partial improvement in single cases prove nothing. There may be something heroic in the country dentist, in desperation and compassion, purchasing appliances and attempting, at a loss to himself, to improve some pitiful little mouth that has no other chance. But every orthodontist has seen cases that were attempted by general practitioners, that were far worse than if they had never been attempted at all. Even a course in orthodontia is not adequate equipment if the man does not thereafter limit his work to the specialty. The course does not make an orthodontist, but simply starts him to thinking and working along definite lines, which, if he follows them and possesses the aptitude, will make an orthodontist. More time and work are required for this than can be spared from a general practice.

Weak as is the defense of the orthodontic efforts of the country dentist, the general dentist in a community containing an orthodontist lacks even that. There is no excuse for his attempting a single case.

The average level of the standards of orthodontic service is low enough among men doing exclusive practice. Think of the effect upon that average of the inclusion of a large group of unprepared men, devoting only a fraction of their time to the work, not enough to know what it is all about. We cannot look to the performance of orthodontic service by general dentists as offering any help in the solution of the problem. Do not mistake my attitude for one of jealous animosity. If such dentists have a sincere love of orthodontics, the thing for them to do is to prepare themselves in the specialty and practice it exclusively, or let it alone.

The Southwestern Society has an educational committee composed of T. W. Sorrels, Robison, and Duckworth, who have been working to secure the discontinuance of the orthodontic appliance, "diagnosis and treatment" advertisements from dental periodicals. Much credit also goes to Spencer for work toward this end. I believe we are about to see such advertising wiped out of existence in this country in the immediate future.

In maintaining the standards and spreading the benefits of orthodontia, it is necessary that we work for the right kind of legislation. Arizona and Illinois have already established legal requirements for specialization in orthodontia and the other dental specialties. The Tennessee State Dental Society had a program prepared for presentation to their state legislature in January of this year, and I do not know the outcome. The men from Oklahoma are to be congratulated on the passage this year of their dental specialists law. I think we of the other states would do well to work for the passage of similar laws, only stronger. Personally I favor putting it in the law that orthodontia is to be practiced only by dentists who have received special instruction and are qualified by examination, and then only exclusively. There is nothing in the Oklahoma law as I see it to keep every dentist in the state from doing orthodontia along with his other work. Before we can hope for such laws as I advocate, it is necessary that we demonstrate our ability to take care of the public's needs.

Let us consider some of the obstacles which we are going to have to overcome in carrying out the aim I have proposed. The principal ones, it seems to me, are the adjustment of fees, inaccessibility, and mental barriers on the part of parents.

With regard to fees, it probably seems to all of us that six years of depression have driven our fees down to the lowest average on which we can work with any comfort and maintain anything like the proper standards. Perhaps that is true; perhaps it is not going to be necessary for us to make further reductions; in fact, we may get a few better fees. But the many younger men who will enter the specialty from year to year are going to have to be content with less and to work harder for it.

In many instances the bugbear of the expensiveness of orthodontic treatment is more hearsay and exaggeration than fact. It is queer but true that almost every one who has paid an orthodontic fee boasts of having paid a much larger amount than is actually the case. This is certain to frighten many parents away who have children badly in need of treatment.

I am in no way suggesting the cheapening of any man's work or lowering of standards; nor that any man work at fees too low for his best skill; nor that any man surrender his right to set the fees for his work upon his own patients. If you have been struggling to maintain the standards of your work at the highest, and have found few who appreciated your efforts to do so, there is some comfort for you in the following words which I quote from Elbert Hubbard: "As men and women increase in refinement, they want fewer things and they want better things. The cheap article, I will admit, ministers to a certain grade of intellect; but if the man grows, there will come a time when, instead of a great many cheap and shoddy things, he will want a few good things. He will want things that symbolize solidity, truth, genuineness and beauty."

I mentioned inaccessibility as another obstacle to be overcome. Naturally the larger cities are being well supplied with orthodontists first and then the smaller cities. There remain many towns too small to support an orthodontist, which can nevertheless take part of the time of one. Already this difficulty is being worked out, and will continue to be. A few men now have branch offices; in the future many will no doubt build practices by dividing their time among several small towns. Many towns which we think of as too small to support an orthodontist will later be supporting one or more, with their trade territory.

I referred to the obstacle of mental barriers on the part of parents, meaning ignorance, hard-headedness, indifference, selfishness, etc. To meet these, education is necessary, and we shall have to be the educators. Do not hide your candle under a bushel. It becomes more than ever a professional obligation that we take advantage of every opportunity to speak over the radio, before parent-teachers associations, and make other public appearances. Of much greater importance, however, in my opinion, is the educational work we do at the chair and in our offices. Here we become the directors of education, and our patients and their parents become the educators. The good or bad effects of the picture we paint of orthodontia in the minds of those we serve extend far beyond the limits of our locality. Parents tell me of things which ortho-

dontists in St. Louis, New York, or elsewhere have done, or failed to do, which created a bad impression. Whether we want to or not, we are always molding public opinion in all our contacts with our patients. This thought no doubt frequently occurs to you and influences your action, as it does mine.

Obviously the carrying out of this aim will require many times the number of orthodontists that exist at present. In the matters of attracting desirable recruits to our ranks and of educating them we can all have a hand and a voice. Much can be said on the subject, but it is not my intention to bring that within the scope of this paper. I would only sound a warning that in striving for quantity we must never fail to put quality first. We must solicit the highest type of young men in mental and moral qualifications; and educational requirements must be raised and standardized.

In conclusion, let me summarize my remarks concerning the present status and future of the profession in the United States. The most pressing problems are those of supply and distribution. These are complicated by a social unrest. About 1 per cent of serious cases are now treated. The need is recognized by the leaders of the dental and orthodontic professions. Unless we handle the problem, it will be handled for us. The problem is linked with price consideration. I propose the aim "Orthodontia for every family of average means within the next generation." The general practitioner doing orthodontia is a failure. Legislation may be of great assistance. The obstacles of cost, inaccessibility, and mental barriers of parents are not insuperable. Desirable recruits must be attracted and educated.

4115 FANNIN STREET

## ORTHODONTIC RESEARCH AS A COMPONENT PART OF A BALANCED LONGITUDINAL STUDY OF 100 CHILDREN

CHARLES M. WALDO, D.D.S., DENVER, COLO.

IT IS the purpose of this paper to describe a type of research which seems to me best adapted to the solution of many of our orthodontic problems and to show how the program of the Child Research Council is designed to assist in this work. The description given is of a rather general nature, and in many instances I have attempted to suggest rather than to enumerate the manifold possibilities of this type of study and to suggest the complex nature of its problems.

The studies of those men who have made extensive analyses of the orthodontic literature and the experiences of those whose studies have been much less extensive both serve to indicate a great need for basic knowledge supported by evidence which will stand the test of scientific analysis. The controversial and contradictory nature of information pertaining to that phase of orthodontics usually described as the biologic part is evidence of the preponderance of theory over knowledge, a preponderance which grows as we leave the field of general biology and deal more specifically with the human organism. We find ourselves seriously handicapped in the daily practice of our specialty by the many unanswered questions which arise. Most of these questions have been given consideration. Some of them have been studied for years by very able men, yet they remain unanswered.

Our major problems differ only superficially from those of other branches of medicine. The unanswered questions which puzzle us are in many cases the same ones which puzzle the pediatrician or the otolaryngologist, and most of them have a common source—our lack of knowledge of human beings, more specifically, of the growing child.

Our situation is similar to that of a person trying to translate something written in an unfamiliar language of which he knows only a few words. No amount of effort is likely to give him the meaning of what is written until he enlarges his vocabulary. The information which we need is as fundamental and indispensable as an adequate vocabulary, and it is the task of research to supply this working knowledge which will place us in a position to attack our problems with some assurance of success.

It is reasonable to suppose that we must first build a rather complete picture of knowledge concerning the growing child—what conditions exist at birth—what changes in structure and function occur as he passes through the various age periods to maturity—within what limits may structure and func-

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From the Child Research Council and the University of Colorado School of Medicine.  
Presented before the Southwestern Society of Orthodontists, Houston, Texas, October 31, November 1 and 2, 1935.

tion vary and still be consistent with health. In other words, we must find out what does occur, what conditions do exist, before we can explain how or why, or evaluate the relative rôles of heredity and environment.

There are a number of ways in which we may hope to obtain this information, and, aside from laboratory experiment, they consist of the observation and examination of children. The methods followed in such observation may differ widely but in general may be divided into two groups—those which involve the study of a large number of individuals over a short period of time, and those which deal with a relatively small group of individuals studied over a long period of time.

The first method is used as the basis of most statistical studies. It is adapted to obtaining such data as the incidence of dental caries, the age at which the various teeth erupt, the characteristic symptoms of disease processes, and an almost unlimited variety of information of a like nature. This method has been in use for a long time and is so familiar that it needs no further explanation.

Many studies of children have been approached in this way, and the bulk of our information about the child has been pieced together from the results of such studies. There is, undoubtedly, much more to be learned by this method, but it has several distinct limitations. It gives its results in terms of averages which tend to obscure individual differences as well as the character of changes which take place during growth and development. This accounts, in part, for the difficulties which we encounter in practice when we attempt to study our patients as individuals rather than as members of a group or class. Studies employing this method tend to be isolated in that they seek information regarding a particular condition of a particular part or function. In addition, there is no sound basis for the assumption that the compiling of information gathered by many studies of different children will give us a true picture of growth and development. Experience in the use of such information seems to indicate that it does not.

The second method, that which consists of a study of a relatively small group of the same individuals over a long period of time, is rapidly gaining favor and seems to be the method best adapted to secure the information which we need. Although the value of this method was stressed first almost half a century ago, it is only in recent years that it has received the general recognition which it deserves. There are now a number of research institutions employing this type of study, one of which is the Child Research Council of Denver.

At the beginning in 1922 the Selme Winter Foundation, which later became the Child Research Council, had for its purpose a long-time radiographic study of the lungs of a group of children who also received periodic physical examinations. Since its organization as the Child Research Council and association with the University of Colorado School of Medicine in 1927, there has been a constant increase in the size of the staff and the scope of the study, an increase which has been aided materially since 1930 by the financial support of the Commonwealth Fund of New York. At the present time the

Child Research Council occupies quarters at the University of Colorado School of Medicine. Its staff consists of 20 full-time salaried research workers who are trained not only in their special fields but in the handling of children as well, and a volunteer staff of 32 members including leading practitioners of the community and medical scientists from the faculty of the medical school. Members of the salaried staff devote their entire time to a study of the children in the group under observation or to correlated laboratory and specialized problems, or, in many instances, to both. For example, as Fellow in Orthodontia, my work consists of a study of the faces, jaws, and teeth of these children, the planning of technic and equipment to be used in this study, and, at present, a correlated study of the jaws of infants at Florence Crittenton Home in Denver. In this work I receive the advice of Dr. Albert H. Ketcham, who is a member of the volunteer staff and Consultant in Orthodontia.\*

There are 100 children in the group under observation who come from homes of various social and economic positions in the community, representing roughly a cross-section of the population. There has been no attempt to select special cases for this group. They are first seen at the age of two to four weeks, and as far as it is possible to tell at this time they are just average healthy children. Examinations are made periodically by members of the various departments, and records are made of all relevant details whether they pertain to health or disease. These records are made objectively so far as it is possible to do so on a basis of existing methods. Both records and methods are carefully checked and rechecked. For the most part the methods and equipment used are those available to the practitioner, and with the aid of members of the volunteer staff each study is conducted with a consideration for its clinical significance. At the present time examinations include routine physical examinations, radiographs of the head, the teeth, the heart, the lungs, the intestines, and the bones, electrocardiographic tracings, recording of blood pressure, determinations of basal metabolism, plaster impressions of the teeth, anthropometric measurements, posture and head photographs, and many others. It is the plan of the Child Research Council to continue these thorough, carefully checked examinations from birth through adolescence to maturity, following this same group of individuals, the emphasis of all the various studies being placed upon the whole child as a living, growing human being.

The orthodontic study, then, is only one of many studies designed to give a more complete and accurate picture of the growing child, to aid in filling in that portion of the whole picture which is the special field of orthodontics. As a purely orthodontic study, however, its value is increased both by the type of material available and by the wealth of information regarding that material supplied by the other studies.

Time does not permit me to describe the methods used in carrying out the work of the many departments of the Child Research Council. The very nature of the plan of attack and the fact that the orthodontic study has been

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\*The Fellowship in Orthodontia was created and an active orthodontic study added to the Child Research Council program in 1932, largely through the efforts of Dr. Ketcham. Until his death in December, 1935, he served as Consultant in Orthodontia, and from him I received much helpful advice and encouragement.

in progress less than three years make it impossible to report definite findings at the present time. I should like, however, to outline briefly the orthodontic program and point out the nature of the information which we hope to obtain.

The examinations and records consist of oral examinations, dental casts, profile and full-face photographs, dental and head radiographs.

The oral examination is made for the purpose of recording those conditions existing in the mouth at the time of examination which may be observed with the aid of a mirror and an explorer, consisting of such conditions as mouth hygiene, occlusion, state of eruption of the dentition, dental caries, developmental defects, and pathologic conditions. Information given by the parent or the child regarding habits, history of trauma, etc., is also recorded on the chart provided.

Casts are made from plaster impressions except in the case of very young or timid children, when impression compound is used. The anatomic portions of these casts are made from stone for the sake of permanence, and every precaution is taken to insure accuracy. Gnathostatic casts were considered in planning the study but ruled out at that time because of the desirability of using plaster as an impression medium and because of the predominance of very young children in the group. I have since found that very satisfactory casts recording the Frankfort and orbital planes may be made from plaster impressions using a simplified Simon technic which is applicable in most cases to the younger children. I have used this technic in special cases but have not adopted it as routine because I feel that the head radiographs supply the same information more accurately.

Profile and full-face photographs are made one-fourth life size, equipment designed by Dr. Ketcham being used. This equipment is similar in the essentials of design and operation to that used in the Simon technic except that it employs a lens of much longer focal length, tending to minimize distortion.

The dental radiographs consist of four extraoral and four intraoral views, extraoral views of the canine regions being added to those of the molar regions usually made. Intraoral views are made of the incisor regions only. The technic employed differs from that in common use in that the milliamperage is much higher, the exposure time much shorter, the target film distance much greater (about 30 inches), and the x-ray tube fixed in a vertical position necessitating orientation of the patient to the tube rather than vice versa. An increased stability of the patient, who in all cases lies full length on a table beneath the x-ray tube, combined with decreased exposure time and increased target film distance makes for uniformity and excellence of detail. This technic is especially suited to a study of children of all ages, since by its use it is possible to obtain satisfactory films on babies and uncooperative children.

The head radiographs are made in lateral and anteroposterior positions by a carefully standardized technic which is similar in principle to that used by Dr. Holly Broadbent at Western Reserve University. The development of this technic and of the necessary equipment has been one of the most interesting and enjoyable phases of my work, and I wish that time permitted a detailed description of it. At this time I can say only that the equipment is

much simpler than that used by Dr. Broadbent and the results are comparable. The essential feature is that all variable factors are controlled so that the differences apparent in successive radiographs made on the same child are those brought about by growth and development. These radiographs are traced, important landmarks of the bony framework of the face and cranium, the denture, and soft tissues located, and measurements made. I know of no method of equal value for the study of growth changes in this region, and I hope that it may one day be available for use in orthodontic practice.

As in the planning of orthodontic treatment the methods to be used in this type of study must be selected with much care and forethought, since the length of time which must pass before results can be observed is necessarily great. Time spent in a thorough preparation is of little significance compared to that lost if it is necessary to make radical changes at a later date. For that reason emphasis has, so far, been placed upon planning of the program and careful recording of the data obtained. Analysis, evaluation, and correlation of these data will, logically, come much later.

From a certain standpoint it would be desirable in our study to avoid treatment altogether. The welfare of the children must be considered, however, and it is the practice at the Child Research Council to inform the parents whenever treatment is indicated. Information concerning the child is placed at the disposal of the family physician or dentist. There are but seven children of the group under orthodontic treatment at the present time. Others with varying degrees of malocclusion are unable to afford treatment, and, while it is unfortunate for the child, at the same time it offers an excellent opportunity to study cases which would ordinarily be placed under treatment in practice.

Figs. 1 and 2 illustrate this type of study material. Fig. 1 is a case of a boy eight years eleven months of age which I believe would be treated without hesitation in almost any practice. The maxillary left posterior teeth are entirely buccal to the opposing teeth of the mandibular arch except for the tip of the lingual cusp of the maxillary permanent first molar which is in the process of eruption. There is also a marked malalignment of the maxillary incisors, with a deep overbite and a rather marked overjet. Spaces occupied by the deciduous mandibular right lateral incisor and left first molar have partially closed. There is a definite asymmetry of both arches seen from the occlusal surface and a discrepancy in vertical development of the molar regions of the maxillary arch. I should like to add that head radiographs show a corresponding discrepancy in vertical development of the bony framework of the face in the region of the orbit as well as in that of the maxilla. There is no history of habit except for a possible resting of the face on the hand in studying. Both habit and premature loss of deciduous teeth may be factors in the etiology of this case, but the extent of asymmetry would seem to indicate other, possibly more important, ones.

Casts of another boy made at two and at three years of age are shown in Fig. 2. He probably would not be seen by an orthodontist because of his age and the relatively inconspicuous nature of the developing malocclusion. The

financial situation of his parents is likely to prohibit treatment at any age. In the second cast note the similarity to the previous case in that the maxillary posterior teeth of the left side are entirely buccal to the opposing mandibular teeth. The first cast shows a tendency toward this condition already apparent at two years of age. There is no history of habit in this case. It will be interesting to observe the dentitions of these two boys, especially since they are brothers and since our group includes another brother of intermediate age who so far has shown no evidence of malocclusion. The casts shown in Figs. 1 and 2 illustrate one type of study material, i.e., cases of evident malocclusion not under treatment.

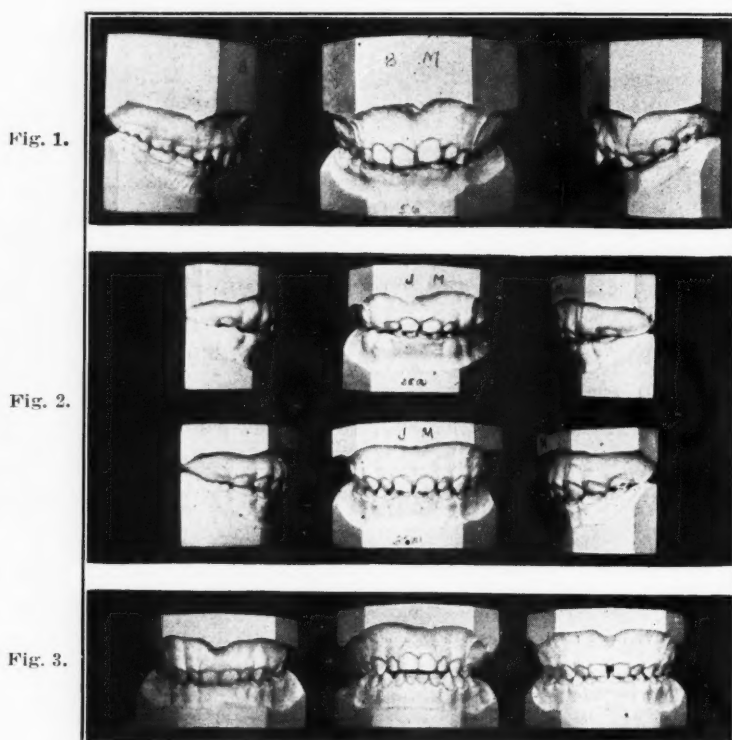


Fig. 1.—First type of study material—evident malocclusion, untreated. B. M. ♂, eight years eleven months.

Fig. 2.—Evident malocclusion, untreated. J. M. ♂, two years no months and three years no months. Brother of B. M. (Fig. 1.)

Fig. 3.—Second type of study material—borderline malocclusions.

The casts shown in Fig. 3 represent borderline cases which might be observed or treated if they should be referred to an orthodontist. Their observation will be carried on for a longer period of time and, with the aid of the other departments, more thoroughly than would be possible in practice. These illustrate a second type of study material included in our group.

In addition to those who show definite evidence of malocclusion, a considerable number, especially among the younger children, show little of interest from this standpoint. Unless malocclusion becomes evident, these are cases which would not ordinarily be seen by the orthodontist, and they represent a relatively neglected portion of the field of orthodontic study. These “nor-

mal" cases (Fig. 4) are an important part of our study material and are observed as carefully and thoroughly as those showing malocclusion. It is impossible, of course, to foretell how many cases which earlier seemed to be cases of malocclusion will later be added to this group. Fig. 5 shows casts of a boy, made at five years eight months and at nine years one month. Note the definite improvement which has taken place without treatment. It is equally impossible to foretell how many of these normal cases will show symptoms of malocclusion later, such as the one shown in Fig. 6. These casts are of the same patient, a girl, made at the ages of six years eleven months and eight years eleven months. Whenever such change becomes apparent, it may be possible through an examination of previous records to detect early symptoms of that change which we are not able to recognize at present. Much of our hope for knowledge which will allow us to prevent malocclusion lies in such a study;

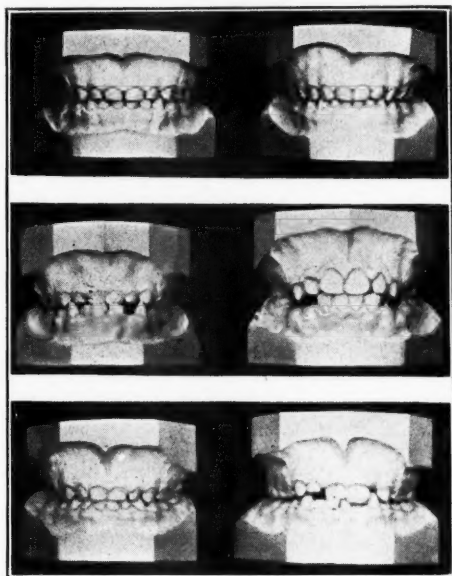


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 4.—Third type of study material—"normal" cases.

Fig. 5.—J. S. ♂, five years eight months and nine years one month. Note improvement in incisor relation.

Fig. 6.—J. R. ♀, six years eleven months and eight years eleven months. Note change to malocclusion.

yet, when malocclusion becomes apparent, it is already too late to obtain necessary information unless provision has been made.

These examples illustrate roughly the types of study material within our group and are shown in the hope that they will suggest many features and possibilities of this study which time does not permit me to discuss. I have purposely avoided the presentation of such statistical data as the incidence of malocclusion with its various subdivisions and classifications. It seems to me that any statement of such incidence is only temporarily accurate, that it is a figure which changes constantly as the individual members of the group grow and develop, that it tends to disclose only group changes and is of importance to this study at the present time only in that it shows the group to be roughly a representative one.

The chief value of our study lies in the observation of individuals, rather than the group as a whole, in following without prejudice children with a wide variety of dentitions to see what happens to those dentitions, how the various characteristics change throughout the successive age periods, and, by correlation of the information obtained with that from other departments studying the same children, in determining which conditions are consistent with

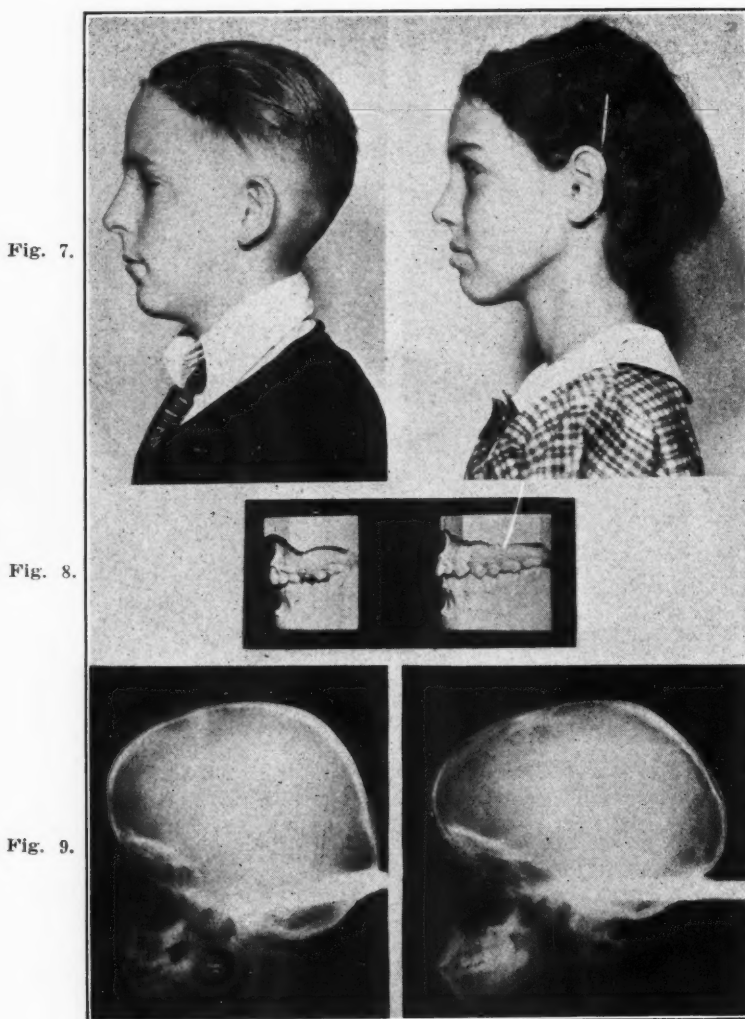


Fig. 7.

Fig. 8.

Fig. 9.

Fig. 7.—Profile photographs of W. J., a boy eleven and one-half years old, and C. S., a girl of the same age. Note the difference in jaw development.

Fig. 8.—Plaster impressions of W. J. (left) and C. S. (right) made at the same age as the photographs shown in Fig. 7. Note the striking differences in development of the teeth.

Fig. 9.—Lateral roentgenograms of head of W. J. (left) and C. S. (right) made at the same age as photographs and impressions (Figs. 7 and 8).

health and which are not. It is, then, a study that must recognize and be guided by a realization that individuals vary. Figs. 7 to 15 have been taken from the Child Research Council records and serve to illustrate individual variation in structure, function, and response to environment. These illustrations were used by Dr. A. H. Washburn in his paper *The Significance of Indi-*

*vidual Variation*,\* given before the American Pediatric Society in Cleveland last May, and the following observations regarding them are his.

"The first pictures (Fig. 7) represent the sort of individual difference with which we are so familiar that it is taken for granted. In our studies we attempt to translate our rough impressions into some sort of objective record which will be both measurable and permanent. Here we have accurate profile photographs, taken to scale, of two children of the same age. Although some of the striking differences are, of course, dependent upon sex, many others are quite unrelated to the fact that one happens to be a boy and the other a girl. I should like to call your attention particularly to the characteristics of the lower face and jaws of these two youngsters.

"In the next illustration (Fig. 8) are shown photographs of accurate casts of the teeth of these two children shown in Fig. 7. Even the most superficial inspection shows striking differences in the development and contour of these jaws. Such differences may be measured in three dimensions, recorded and studied year by year as these children grow and develop from

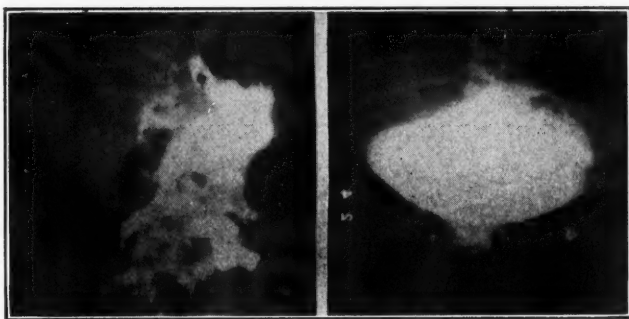


Fig. 10.—Visualization of the stomachs of two healthy babies of the same age and size, following the ingestion of approximately equal amounts of formula and barium. This illustrates the extremes of individual variation.

early infancy to maturity. By repeating the same process on 100 children the zone of individual variation may be constructed slowly but surely.

"In Fig. 9 are reproduced the lateral head roentgenograms of these same two children. By means of these x-ray pictures combined with anteroposterior x-ray pictures, all taken in the same relative positions, one can visualize and measure the fundamental underlying structures which are responsible for the variations already noted. In serial roentgenograms of this sort, taken each year on a group of children, one can study the component parts of the development of the face and jaws as they grow, and thus analyze the differences between individuals.

"These three figures, then, illustrate two points: first, the simple picture of variation in structures; and second, a method for accurate objective study of the differences in growth and development from birth to maturity in two or more children.

"The next two films (Fig. 10) illustrate the unusual amount of difference sometimes encountered in one single examination of two infants. These two

\*Journal of Pediatrics 8: 31, 1936.

roentgenograms were taken of two babies of about the same age and size and at the same time interval following the ingestion of their regular formula to which barium had been added. It may be noted that a large portion of the barium meal in the one baby has already moved along into the small intestine while in the other most of the meal is still in the stomach, which seems quite enormous. We see here an illustration of individual variation which involves both structure and function.

"In the next illustration (Fig. 11A) is seen not the hearts of two different children but roentgenograms of the same child in the supine (left) and in the upright positions. I should like to have you compare this situation with that shown in the next picture (Fig. 11B). Here we see chest roentgenograms of another healthy child taken, as before, both in supine and upright positions.

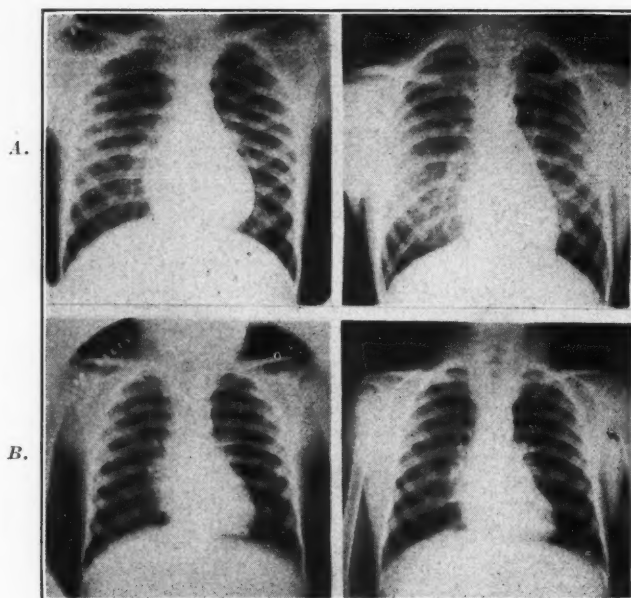


Fig. 11A.—Chest roentgenograms of W. M. in supine (left) and upright positions, showing marked alteration in heart shape with change in posture. Note also relatively heavy "lung markings."

Fig. 11B.—Chest roentgenograms on M. L. in supine (left) and upright positions. Contrast the absence of change in heart shape and the relatively light "lung markings" with these same findings in W. M. (Fig. 11A).

No appreciable change is noted in the shape of the heart. It may be interesting also to compare two things in this child's chest with the same findings in the first child—note the shape of the heart and the heaviness of the shadows cast by the bronchi and pulmonary vessels. We may interpret Figs. 11A and B as illustrating two points: first, that the differences in structures are not just skin deep but include also the essential internal organs; and second, that these differences involve not merely the form of that structure but also its response to changes in environmental conditions. As one is confronted with more and more data of this sort, one becomes increasingly impressed with the complexity of this concept of the so-called 'normal.' For what is normal for one child—e.g., a heart which shows no change with a shift in position—is

not at all normal for the other child. This situation is even more striking in view of the fact that the heart is one organ whose shape and general contour, as shown on serial x-ray plates, changes remarkably little from early infancy to adolescence.

"The next three illustrations depict the same type of picture of variations, but this time in the realm of function rather than of structure. Fig. 12 shows selected tracings of the respiration of four healthy babies within the same age

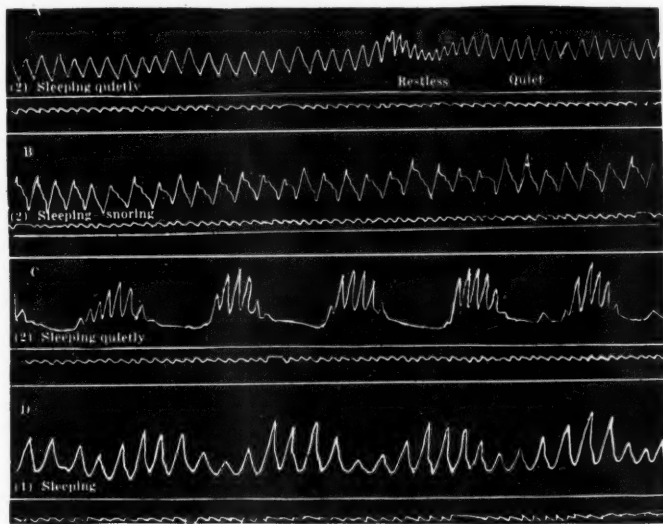


Fig. 12.—Tracings of the respirations on four healthy infants showing marked individual differences.

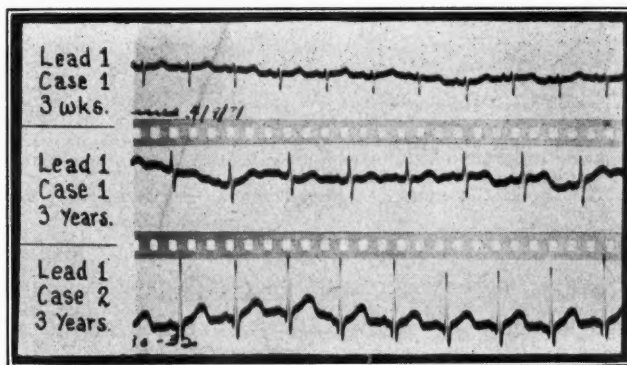


Fig. 13.—Electrocardiograms showing variations in the findings on one individual at different ages and variations between two individuals of the same age.

period of three to six weeks, and all taken during apparently quiet sleep. Some babies may show a shift from the smooth, even type of breathing shown in the top tracing to the markedly periodic type shown in the third tracing within one brief period of observation. Even in the portrayal of one fairly simple function, then, we still find our expected picture of variation both in one individual and between different individuals.

"In the second of this group (Fig. 13) I have tried to demonstrate the presence of a similar picture which will be found when we try to obtain a

permanent record which will portray cardiac function. The upper two tracings are taken on the same child at the ages of three weeks and three years. The lowest tracing is from a different child in our group of healthy youngsters—also at the age of three years. No intricate knowledge of electrocardiography is needed to see that each of these tracings is strikingly different from the other two.

“Another rather complex picture is presented by charting the results of 411 basal metabolism determinations on eighty-one children, between the ages of two and twelve years (Fig. 14). However, I believe it illustrates unusually well the stretching out of a health zone within which individual variations are seen to be quite marked as between different children and definitely less marked, but still present, over a given time in any one child. It also shows a definite difference between the sexes and the tendency for the rate on any one child to stay, roughly, in the same general part of the large zone. To bring

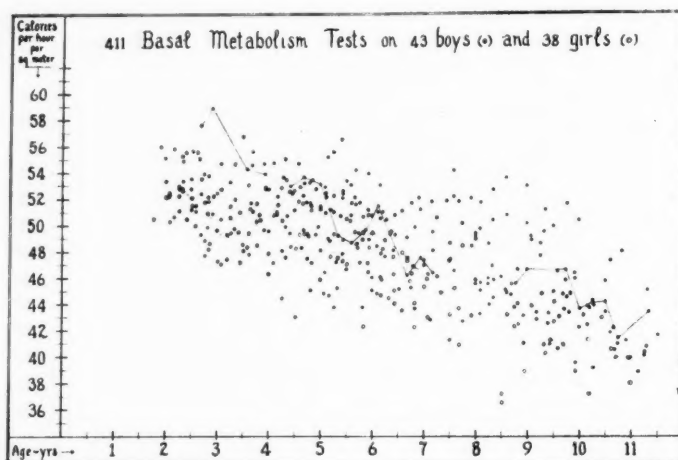


Fig. 14.—Individual variation in basal metabolic rates illustrating: the wide zone of healthy variation between different children of the same age; the fluctuations in six individual children in successive tests; the difference between the sexes; and the tendency for any one individual's rates to remain in the upper, middle, or lower portion of the zone.

out this latter point I have sketched in the curves for 6 different children—three boys and three girls—covering the whole age period which is depicted.”

Dr. Washburn has emphasized not only the extent of individual variation but its importance in our study of the whole child. We must seek to determine which variations, of the structures and functions of special concern to us as orthodontists, are consistent with the present and future health of the individual. We must be guided in the delineation of such a zone of health by the findings of the other departments of medical science. It is to be hoped that in thus attacking the major problem of filling the gaps in our knowledge of the growing child much information will be forthcoming which will aid in the solution of the special problems incident to orthodontic practice.

Before closing I should like to stress the value of cooperation between the different studies of the Child Research Council and by way of illustration to show how the work of the orthodontic department may be aided by that of

another. I have purposely chosen this illustration because it helps to bring out information which is of interest to orthodontists at the present time.

Fig. 14 in addition to the features which Dr. Washburn pointed out serves to illustrate the work of the department of basal metabolism. This work consists of making accurate, periodic, basal metabolism tests on the group of children under observation. At the time this slide was made 411 such tests had been made. Many more have been made since and will continue to be made for years to come. I could spend much time in a description of the methods involved and the precautions taken in every phase of this work to insure the accuracy of these tests, but I wish to point out that in addition to the light which they throw upon one phase of development of the children whom we are studying they also serve to set up standards or averages to be used in the calculation of the basal metabolic rate. Perhaps I should explain that the result of a basal metabolism test must be compared with an average

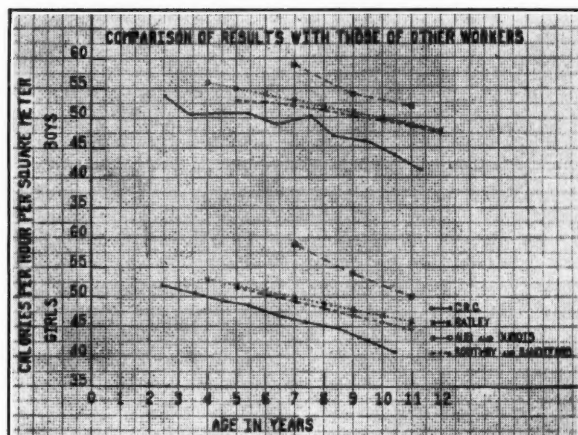


Fig. 15.—Comparison of basal metabolism standards of Bailey, Aub and Du Bois, and Boothby and Sandiford with those based upon Child Research Council findings. Note the wide variations in these four standards.

result to obtain the plus or minus rate with which we are familiar. The rate given, then, is merely a statement of the percentage of deviation of the result obtained from an average result for individuals of the same age and sex. The plus or minus indicates whether that deviation is above or below the average.

Going back to Fig. 14, it will be seen that the general trend of the group shown is toward a lower basal metabolism as age increases. If we were to determine the average for this group at the various age periods, we would have a set of standards which might be used for comparison in the calculation of basal metabolic rate. There are a number of such standards in common use which have been built up in approximately the same way. The important point is that these standards vary widely. Fig. 15 shows how three of the standards in common use clinically differ among themselves and with that for the Child Research Council group.

How much this variation in standards may affect the basal metabolic rate is demonstrated by Fig. 16 which shows the report of a basal metabolism test

of a girl eleven years seven months of age who was tested because she showed a marked delay in the eruption of permanent incisors. The result of her test was 40.9 calories per hour per square meter of body surface, or 970.9 calories per twenty-four hours. For the purpose of illustration, this result has been compared to the four standards shown in Fig. 15, and the discrepancies in the basal metabolic rates obtained are apparent. Note that, depending upon the standard used, the basal metabolic rate in this case varies from a plus 5 to a minus 18. In other words, a simple statement of metabolic rate may mean very little unless the method used for testing and the standard used for com-

Patient Alice C.  
Age 11 years 1 month  
Weight 56.5 lbs.  
Height 133.0 cm.

Result of basal metabolism test - 40.9 calories per hour  
per square meter of body surface.

Standard used for comparison	Average cal./hr./sq.m. for girls 11 years	Basal metabolic rate obtained
Child Research Council	39.1	+ 5
Boothby and Sandiford	44.6	- 8
Bailey	46.0	- 11
Aub and Du Bois	50.0	- 18

Fig. 16.—The result of a basal metabolism test compared with average results taken from the standards shown in Fig. 15 for girls eleven years of age. Note the wide variation in the basal metabolic rates obtained.

parison are taken into consideration. Through the cooperation of skilled workers in basal metabolism this information is obtained and evaluated for comparison with dental findings much more accurately than would be possible otherwise.

I am inclined to accept the standards of the Child Research Council and so far as the basal metabolism test may be used as a measure of thyroid function to consider this girl a normal individual in this respect. If, however, she had been one of your patients and the Aub and Du Bois standard, which is unsatisfactory but still widely used, had been employed, you would receive a report showing her rate to be a minus 18, which might suggest a mild but definite hypothyroidism. Thus, depending solely on selection of the standard, the basal metabolic rate may serve to show that an individual is at the same time a normal case and one of evident hypothyroidism. It is the lack of reliable standards not only in the field of basal metabolism but in many other fields which serves as a stimulus for such studies as ours in the Child Research Council.

It is apparent, then, that the program for orthodontic research which has been presented is a part of a larger concerted effort by orthodontists, physi-

cians, and scientists. They lend their varied knowledge, training, and skill to this project which has for its purpose the creating of reliable health standards during the years of infancy and childhood. The longitudinal method of study of individual children seems to offer the greatest opportunity for building up this picture of where variation in structure or function ceases to be "normal" or healthy deviation and becomes pathologic. A knowledge of the spread of the "normal" range in the growth and development of children is as essential to the orthodontist as to the pediatrician.

## DEVELOPMENT OF THE MANDIBLE\*

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**I**T HAS been shown in previous papers that the mandible in the human fetus grows by additions to the base of the wedge of bone which appears about the 55 mm. stage of intrauterine life, and that growth at the angle and coronoid is subsidiary to the main line of growth of this wedge which is in an upward, backward and outward direction. As growth proceeds the general level of the

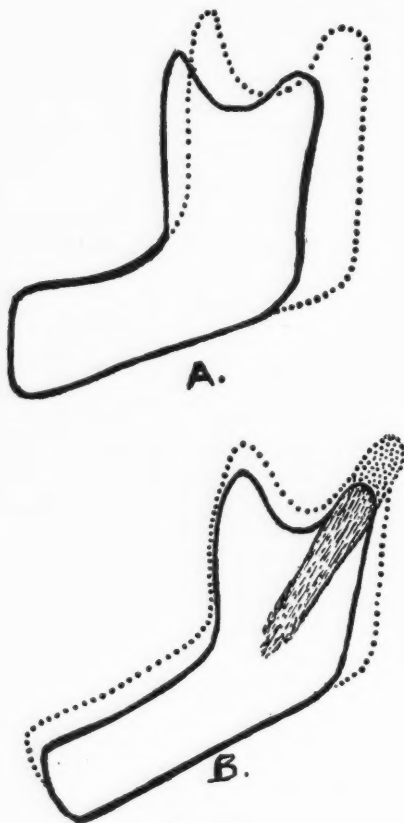


Fig. 1.

tooth sacs is raised relative to the main line of growth. Any obstructing bone at the base of the coronoid is removed as the tooth sacs move upward and forward or is involved in the general upward, forward and outward growth of the tooth sacs and alveolar bone (Fig. 1B).

The evidence in favor of these conclusions was first published in 1925 in a paper "The Temporomandibular Joint and Its Influence on the Growth of the

\*Transactions of British Society for the Study of Orthodontics, 1934.

Mandible'' (*British Dental Journal*, July 15th), and may be summarized as follows: Ossification in the mandible begins about the 18 mm. stage and is preceded by a condensation of cells in the neighborhood of the future bone. This is followed by a simple differentiation of these condensed cells into bone (Fig. 2). About the 50 mm. stage a change takes place at the distal end of the bone. Under its thickened and condensed connective tissue, layers of cartilage cells appear which are rapidly converted into bone (Fig. 3). The mandible being a membrane bone will be formed for the greater part by the direct differentiation

Fig. 2.

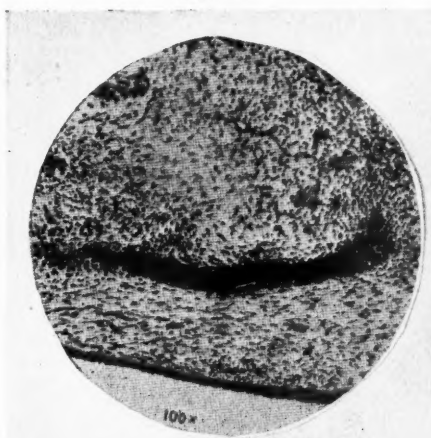


Fig. 3.

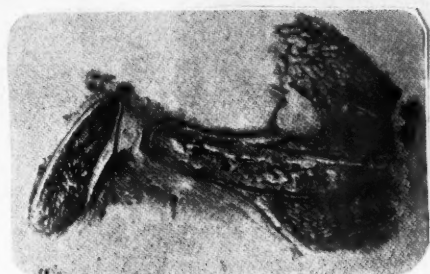


Fig. 4.

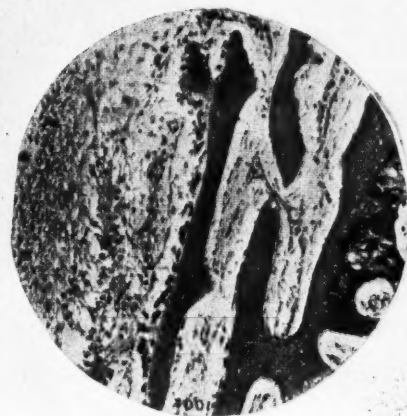


Fig. 5.

of primitive cells into bone, but in certain places where more rapid growth is required there is an intermediate cartilaginous stage. This accounts for the regular appearance of these cells at the condyle and their irregular appearance at the angle and coronoid process. This rapid proliferation of cells at the distal end results in the appearance of a wedge-shaped mass which eventually approximates with the undersurface of the temporal to form the temporomandibular joint. The wedge appears to be cartilaginous, but microscopic examination shows that it is bone with cartilage cells at the distal end only (Fig. 4). These cartilage cells are not removed by a process of invasion; they are ossified independently. There are two definite proofs. (1) Bone formed in membrane

direct and bone formed with an intermediate cartilaginous stage are microscopically different in appearance. They can be seen side by side in the same section and there is no possibility of confusing them (Figs. 5 and 5a). So marked is the difference that a sharp line of demarcation can be seen with the naked eye in a stained section (Fig. 4). (2) Fetal jaws which have been cleared

Fig. 5a.

Fig. 7.



Fig. 8.

Fig. 9.

so that they are translucent show this wedge invaginated into the body of the mandible. In the young fetus it appears as a light strip in a darker mass, but in older jaws it appears as a dark strip in a lighter body.

Growth continues to take place at the distal end of the condylar process, and the body of the bone, which is at the other end, is pushed downward and forward; the condyle itself growing upward, backward and outward. If no

other growth took place, this would result in a body with a long wedge attached to it, but as the wedge grows so does the bone of the body and ascending ramus advance and envelop it. It is as if there were two entirely different substances moving in opposite directions, the one, the growing condyle, pushing the body of the mandible downward while the body itself grows upward around it. Actually the condyle is added to, and the continuity of the whole bone is maintained by the upward and backward growth taking place in front of the condyle and behind it.

The examination of large numbers of serial sections shows that growth is taking place in front of the condyle and coronoid, and that there is no mass absorption with the exception of slight modelling absorption (Fig. 6). This is in direct opposition to the findings of Kölliker, who claimed to have demonstrated that extensive absorption took place in front of the coronoid and condyle in the human fetus. Now, as there is bone growth and not absorption in front of the condyle, and the mandible grows by elongation of the wedge with an upward enveloping growth of the simple bone in which it is embedded, it follows that the continuity of the wedge is maintained. The alveolar border and enclosed tooth sacs make a definite angle with the main line of growth of the condyle and, as the alveolar border increases in height and as (1) the distance from the incisor region to the front of the coronoid and (2) the distance between opposite teeth also increases, it follows that the teeth must move upward, forward and outward.

It now remains to be seen how far this is applicable to the mandible of the growing child. This has been done by examining animals during growth and correlating the results with those obtained from the examination of human mandibles and the measurements of living children.

Previous to the commencement of ossification in the mandible of the human fetus, there has been a differentiation of the ectoderm which results in the formation of the dental lamina and, eventually, the buds of the deciduous teeth and first permanent molars. The mandible rapidly becomes trough shaped, having the inferior dental artery and nerve toward the floor, with the dental lamina and tooth buds suspended from above (Fig. 7). The enamel organ of each tooth becomes bell shaped, and the mesoderm in the neighborhood of each bud develops to form the dental papilla; but, as growth progresses, the surrounding undifferentiated tissue grows up and completely envelops it. The vertical depth of the lamina increases, i.e., the tooth buds come to lie more deeply, but this is due to the upward growth of the alveolar borders with the contained connective tissue; it is not due to the ingrowth or invagination of the original ectoderm or tooth bud. This point is of importance especially in the development of the second and third molars, for they appear often to bury themselves more deeply in the body of the mandible as development proceeds; whereas the appearance is due primarily to the upward growth of the alveolar borders and other contained tissues.

The tooth buds now lie in close relationship with the inferior dental system, which is itself fairly close to the lower border, though with a hollow space in the

bone underneath. This space is connected with a foramen underneath the border of the mandibular foramen. There is at this stage no bone between the tooth sac and the inferior dental nerve, and the dental lamina still connects the tooth bud with the mouth (Fig. 8). Growth is proceeding rapidly at the two alveolar borders, so that both grow upward, while absorption is taking place all round the tooth sac and nerve as they also grow. In the region of the posterior part of the second deciduous molar and the anterior part of the first permanent molar, growth is taking place on the inner alveolar border and along the whole of the coronoid process. Absorption is taking place all round the tooth sacs and under the base of the coronoid, cutting away the overhanging portion as the tooth sac moves upward, while the distal end of the dental lamina is seen lying in the connective tissue above. Above and to the side are nerves and blood vessels which are not clearly seen in sections toward the front, but becoming very definite toward the distal end of the body of the bone. At the same time as the vessels become more definite, the inner alveolar ridge and base of the coronoid come together, so that they bridge over the distal end of the open trough enclosing, in a large canal which leads to the future mandibular foramen, the posterior part of the last tooth bud or sac, with the inferior dental system below and the system of arteries and nerves just mentioned, above. This upper system arises from the inferior dental system outside the mandibular foramen and is of some importance, for the buds of the second and third molars are developed along its course. It will for this reason be called the developmental system.

As soon as the sac of the first molar appears, the developmental system is seen to pass over its posterior wall, which is at this stage in the canal at the distal end of the open trough leading to the mandibular foramen (Fig. 9). Later the posterior part of this canal is constricted so that there is a bony wall behind the tooth sac with a single narrow perforation for the passage of the two arterial and nervous systems. This perforation is in turn constricted until there are two foramina in the posterior wall with a narrow opening between, i.e., the foramina are not completely shut off from one another. As growth proceeds, the foramina are completely separated. The mandibular foramen itself is now seen to divide into three foramina, the large one for the inferior dental system, the small upper one for the developmental system, and another below which leads to a canal running underneath the inferior dental canal. This canal will be discussed later (Fig. 9). Between the large foramen and the upper one is a strip of bone which develops from the posterior wall of the canal at the distal end of the mandibular trough into a bony mass which grows upward and backward as the mandibular foramen grows. By reason of this growth the developmental foramen eventually lengthens into a canal running from the mandibular foramen to a foramen on the anterior surface of the coronoid. The presence of these foramina and canals can be demonstrated in serial sections and by the passage of wires in dried specimens.

The general principles of mandibular growth in the human fetus described in this paper apply with certain modification to many common animals. There is the same cartilaginous bony growth at the condyle, which method of growth per-

sists after birth as it does in the human mandible (Fig. 14). This is especially marked in the rat, and indeed it is obvious from a comparison of developing mandibles that they could not possibly have developed except by growth at the condyle itself, with growth of an entirely different kind along the posterior border (Fig. 10). In the pig there is marked cartilaginous bony growth at the condyle. This, however, differs from man in the direction of the lines of blood vessels in the cartilaginous bone. In man these vessels are usually at an angle of 45 degrees with the horizontal, but in the pig they make a much more acute angle which may be as low as 30 degrees. This is probably due to the greater forward growth in the pig's mandible, in which there is evidence of some absorption on the front of the coronoid, though this is, in all probability, little more than ordinary modelling absorption.

No attempt has been made in this investigation to inquire into the very early fetal development of the pig, but the work which has been done does not

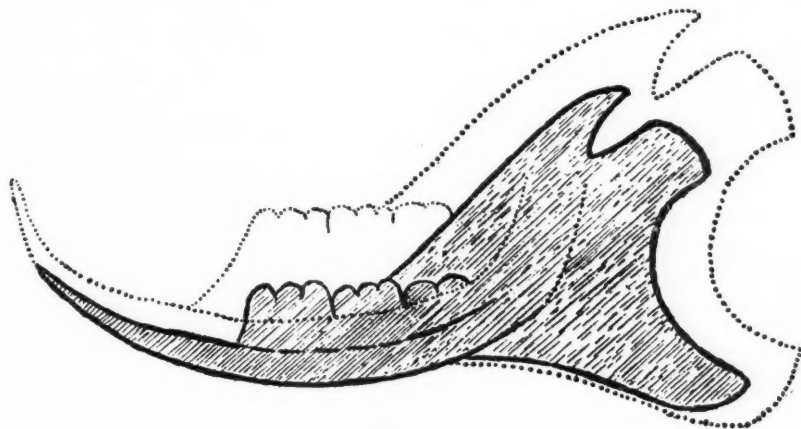


Fig. 10.

suggest that there is any serious difference of principle in the development of the mandible of the fetal pig and of the human fetus. At birth there is not the same constriction of the distal end of the mandibular canal, and the sac of the last tooth lies in and partly outside the mandibular foramen proper, with the inferior dental system underneath and the developmental system above. There is a bony floor underneath the deciduous molars but only the commencement of ossification of the floor of the crypt of the first permanent molar. The space under the bony floor of the tooth sacs is large and carries the inferior dental system and is probably filled with marrow as in older specimens. This cavity differs from that found in the human fetus, for here it actually contains the inferior dental system, but in the human fetus is separated from it, having a separate foramen as entrance. The foramen on the anterior surface of the coronoid has appeared and continues backward as a shallow groove on the under-surface of the coronoid inside the large mandibular canal. As the pig develops, the developmental canal takes definite shape, from the extension backward of the bony covering of the tooth sac. This develops into a bony mass as in the human mandible, though in the case of the pig it definitely projects through the man-

dibular foramen and forms an alveolar bulb which is the counterpart of the alveolar bulb found in the maxilla of the pig.

The maxillary alveolar bulb is a projection at the distal end of the alveolar ridge and when developed, lodges the sacs of the permanent molars (Fig. 11). The maxillary nerve in the pig lies directly over the crypts of the teeth and passes under the antrum, not over it as in man. At birth the last deciduous molar lies in a crypt of very thin bone with the sac of the first permanent molar behind and above, as yet not enclosed in a bony crypt. It is bounded above by the maxillary nerve, behind by the great wing of the sphenoid, and on the inside by the palatal bone. There is no bony boundary to the undersurface, and

Fig. 11.

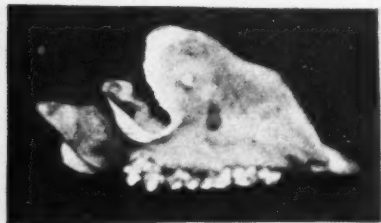


Fig. 12.

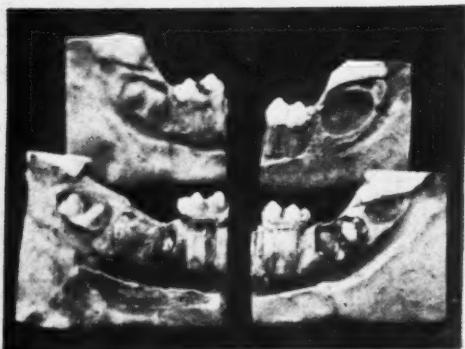
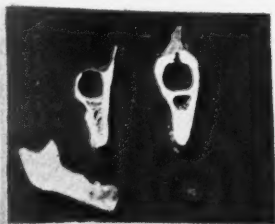


Fig. 13.

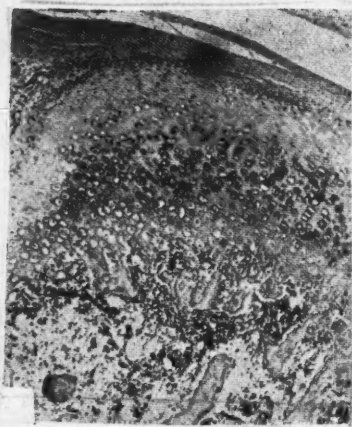


Fig. 14.

the sac itself is attached to a developmental system which comes from the maxillary nerve. The sac is gradually enclosed by the bone of the maxilla which extends from the crypt of the deciduous molar, and this extends further back to form a bony projection pointing upward, backward and inward in which the sacs of the second and third molars develop. The undersurface of the bulb is now a flanged groove which opens into each tooth crypt and is lined with a glistening fibrous covering which is continuous with the periosteum of the bone. The groove itself contains a fibrous sheath containing blood vessels and nerves (the developmental system) which is attached behind to the sheath of the maxillary nerve and in front to bone at the back of the first molar and its connective tissue covering. By the dissection of the firm fibrous attachment behind the first molar it is possible to free the end and shell out the tooth sacs from their crypts.

It is then seen that each sac is firmly connected with this sheath and not with the crypt. Microscopic examination shows the continuity of the blood vessels of the sheath and the tooth sac and, in some cases, the presence of the double layer of epithelial cells which have been derived from the distal end of the dental lamina, and from which the enamel organ of the molars has been formed. It is of interest to note that the mesoblastic tissue from which the dental papilla has been derived can have been derived only from this sheath, for the second and third molars arise as a slight thickening of the sheath in the bony grooves of the alveolar bulb.

In the mandible, the bulb is embedded in the dense bone of the ramus, and is not so obvious. Its development is exactly the same, with the exception that the sac of the last developed molar is not bounded, as in the maxilla, by the sphenoid and palatine bones before ossification of its crypt, but by the mandibular foramen and the large canal leading to it. Prepared older specimens show exactly the same appearance as in the maxillary bulb, with the developmental sheath lying in the canal and with the sacs attached to it. It is obvious from a comparison of human and pig mandibles that the second and third molars are developed in the same manner, and it is difficult to resist the conclusion that the developmental sheath plays an important part in the growth and eruption of the tooth sacs. Professor Brash has brought forward evidence to show that the eruption of the teeth is the result of bone growth, but there is some evidence, apart from the presence of the developmental sheath, to suggest that eruption may be caused by other factors besides bone growth and that bone growth may be secondary to tooth movement; the tooth, in other words, may be moved by some agency and the bone grow up to consolidate the position. In the case of the permanent molars, the developmental sheath is firmly attached to the bone and connective tissue behind the last molar, and as the tooth moves upward and forward and the mandibular foramen backward and upward, it is obvious that the developmental sheath and attached tooth sacs must be carried upward and forward.

The examination of sections shows that the upper part of the developmental canal is being absorbed and that the tip of the alveolar bulb is growing upward, backward and outward. This growth is somewhat less than the growth of the mandibular foramen, for the bulb ceases to protrude from the foramen when the third molar crypt enlarges. It will be seen that the second and third molar crypts are buried much more deeply under the coronoid than are the corresponding molars in man (Fig. 12). There must be, for this reason, much more forward movement of the teeth themselves to release them from the base of the coronoid so that they may erupt. The first molar, when rising into its position in the arch, goes through a complicated series of movements. The distal end is tilted downward as if it were trying to slide under the arch formed by the coronoid (Fig. 13). At the same time it rotates but only sufficiently to permit it to come into line with the last deciduous molar which is moving upward, forward and outward, i.e., it rotates round its own center or posterior border and not round its anterior border. At the same time the crypt for the second molar enlarges, the necessary space being provided by the upward and forward growth

of the first molar. The crypt for the third molar appears as a depression in the developmental canal above and behind the second molar crypt, and the space for the enlarging crypt is provided by the forward movement of the second molar crypt and the backward movement of the tip of the alveolar bulb.

Microscopic examination shows that active growth is taking place at the condyle, tip of coronoid and the posterior border; that the tip of the alveolar bulb is growing upward, backward and outward, though at a slightly less rate than the mandibular foramen which eventually completely encloses it as in man. The measurements made of mandibles of different ages indicate the general direction of bone growth. In the four specimens shown the distance from the mesial surface of the first permanent molar to the apex of the alveolar bulb is increased from 45 mm. to 65 mm., the distance from the alveolar bulb to the lower border from 37 mm. to 48 mm. The distance of the tip of the anterior buccal cusp of the first molar from the lower border increases from 34 mm. in the first specimen to 49 mm. in the last. The angle of a line drawn through the centers of the tooth sacs is, in the first specimen, at an angle of 40 degrees but in the last at an angle of 20 degrees. The distance from the condyle to the tip of the alveolar bulb also increases, but the rate of increase is not equal to the rate of growth of the condyle itself. The diagram based on these measurements shows that, though the tip of the alveolar bulb and the mandibular foramen move backward and upward, the teeth move upward and forward.

In a paper published in the Transactions of the British Society for the Study of Orthodontics in 1926, Professor Brash states that the necessary space for the erupting molars in front of the coronoid is obtained in three ways: (1) By raising the teeth in the growing alveolar border in relation to the backward sloping anterior border of the coronoid. (2) By an upward and forward growth movement of the teeth themselves in the bone as evidenced by continuous reformation and adjustment of the walls of the alveolar cavities. (3) To a very minor degree (and not, as formerly supposed, principally) by absorption of the anterior margin of the coronoid.

These conclusions were based on observations and measurements of the mandibles of madder-fed pigs, and are important to this investigation because they show by another process of reasoning that the mandible does not grow by deposition of bone at the posterior border with mass absorption in front of the condyle and coronoid, but that the teeth move forward and upward relative to the main line of growth.

The madder method has been used on many occasions for the elucidation of the problems of mandibular growth, but a different interpretation from that of Professor Brash's has always been given. This old interpretation was supported by the microscopic investigation of Kölliker, but, as has been stated earlier in this paper, these results are at variance with the results of microscopic examinations described here. There does not, however, appear to be any logical reason for doubting that the madder specimens do indicate bone growth with a fair degree of accuracy, and that Professor Brash's conclusions and those enumerated in the beginning of this paper, for growth in the human fetus, confirm one another.

The measurements of dried human mandibles based on the principles laid down show that the method of growth for the human fetus continues after birth and, with modifications, may be considered to be the method of growth of the child's mandible. These results are confirmed by measurements made on living children, and especially by measurements of children made at different ages. It is hoped to publish these measurements and the description of the method adopted for making them in the near future.

The human mandible may be said, therefore, to grow primarily by additions to the condyle, the bone in front of the condyle and behind growing in such a manner that the continuity of the bone is maintained. In relation to this main line of condylar growth, the teeth and alveolar ridges are always in a state of movement, travelling (in relation to condyle growth) in a forward, upward and outward direction. It follows that the suggestion that the arch formed by the successional teeth is the same as that formed by the deciduous teeth is incorrect, except so far as concerns the actual length. It cannot be too strongly emphasized that the teeth are in constant movement relative to the main line of growth of the mandible, even though they may keep in positions which are fixed relative to one another and that in whatever direction the orthodontist may move the teeth they are themselves always moving in the direction of their normal growth.

#### DISCUSSION

*Dr. G. Northcroft* congratulated Mr. Charles on his excellent paper and his presentation of it. He was very glad to hear Mr. Charles say that it was right to assume that there was a definite movement forward of the teeth through the growing bone; that was an idea that he had himself held for some time. He was also interested to hear that Mr. Charles approved in the main of the idea that the demonstration of growth of the mandible of madder-fed pigs was of value. He thought it was generally recognized that the pig's jaw grew in a somewhat different way from that of the human jaw, having naturally a greater forward growth than the human jaw had, but he thought Mr. Turner was certainly wrong in so very definitely saying that Professor Brash's conclusions were entirely unwarranted. Personally he considered that Professor Brash's investigations had been of great help, and he thought that Mr. Charles had thrown further light on a very difficult and abstruse problem. Some of the slides that Mr. Charles had shown were of great interest, and he supposed that Mr. Charles had a large number of serial sections, which would add to the value of the whole work, though they could not, of course, all be displayed at the meeting.

*Mrs. Lindsay* said that Mr. Charles said the teeth grew upward and outward, but surely he meant inward. They could not grow outward into the coronoid process, so she supposed he meant that the molar teeth inclined inward. There was a Fiji mandible at Russell Square in which the posterior teeth were quite distinct from the coronoid process. They looked as if they were in a separate development of the bone or an outgrowth of the bone. It was a confirmation of Mr. Charles's contention that the interior border of the coronoid process was not extensively absorbed, because in the case she had mentioned there was no necessity for it; the teeth were right inside it and forward from it. Mr. Charles mentioned that underneath the crypt of the tooth, absorption was going on, but she had an illustration of a section of a growing tooth in the crypt where there were alternate layers of deposition and absorption of bone underneath the root. It seemed to prove Professor Brash's contention that it was the upward growth of the alveolar bone which brought the teeth into eruption. Again, she had an x-ray picture where the D had been lost and the 4 had passed up without the growth of the root, and there seemed to be a sort of osteoid tissue underneath it. The crown of the tooth was formed, but there was no root, and the

alveolar bone did not seem to have been deposited underneath it. It all seemed to show that very little was known about eruption. She was interested in what Mr. Charles had said about the teeth picking up the nerves and blood vessels. According to Professor Fawcett, the blood vessels and nerves seemed to be lying along the developing jaw. She often wondered whether the blood vessels and nerves grew down from the cranial portion into the jaw, but Mr. Charles spoke of them as growing upward, as if they were going back. Was there no trace of nervous tissue in the tooth follicle? Eustacius suggested that there were nerves in the tooth follicle and that when the tooth calcified those nerves remained, which might explain the nerves in the dentine.

*Mr. Shelling* said that the mandibles of pigs had been found useful in the old days when there were no human jaws available. He thought the difference was that in the human being the incisors were vertical, whereas the pig had incisors which projected forward in the horizontal direction. A very common defect in dogs was to have what was called a pig jaw.

## GROWTH OF THE JAWS AND THE ETIOLOGY OF MALOCCLUSION

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*(Continued from page 590, June)*

### CHAPTER XI

#### DIAGNOSIS OF THE ETIOLOGY OF MALOCCLUSION

From the preceding chapters it appears that the diagnosis of the etiology of malocclusion is necessary before intelligent orthodontic treatment can be instituted. Advance information regarding a given case can be obtained only from a thorough study of all possible etiologic influences. Since inherited malocclusions do not respond to treatment so readily as the acquired malocclusions, it becomes necessary to decide whether the case under consideration is due to inheritance or to injurious agents. If the condition is properly classed as an inherited malocclusion, the probable outcome of the case is doubtful. The prognosis is always more favorable in cases of acquired conditions, which, as we have seen, may be local or general. For successful results all local causes must be eliminated, and the effects of the general causes may be overcome with the cooperation of a physician.

In order to facilitate routine examinations, a diagnostic chart has been devised which shows at a glance the conditions which may have been responsible for the malocclusion under consideration (Figs. 28 and 29). The chart is divided into three main sections, in accordance with the three divisions of the history as previously described. The first division on the left side of the chart contains the history of the mother before and during pregnancy. A negative history in this division excludes the possibility of harmful antenatal influences, while the occurrence of diseases and other injurious conditions suggests that the malocclusion is at least partly if not entirely due to noxious influences. It must be remarked, however, that while the fetus develops at the expense of the mother, often a healthy child may be borne by a physically unfit mother; but systemic poisoning invariably affects the child. This division of the history deserves careful consideration.

The second division of the chart contains the Angle classification of the occlusion of the patient, parents, brothers, sisters, and blood relatives. From this division, if properly filled, the probable existence of an inherited condition may be traced. It is possible, however, that an inherited condition is not found in either parent or in other children. For this reason the findings in this division must be evaluated in terms of the data found in the other divisions. If the condition repeats itself in several members of the family, and the effect of noxious influences is not indicated in the other divisions, we are dealing with a malocclu-

\*Chief of Orthodontic Clinic of the Hospital of Joint Diseases.

sion due to pure inheritance. When the condition repeats itself in several members of the family but the effect of injurious agents is also indicated, the condition is due partly to inheritance and partly to injurious agents. Malocclusions which are not found in other members of the family are considered as inherited malocclusions in the absence of injurious influences during the critical periods. The probability still remains that those malocclusions which are not repeated in the family and are associated with injurious influences during the

Patient's Name		O.P.D. Number			
Father's Name		Model Number			
Address					
Referred by		Date of Admission to Clinic			
ASSIGNED TO		DATE	AGE	HEIGHT	WEIGHT
GROUP	Dr.				
	Dr.				
GROUP	Dr.				
	Dr. OPERATORS				
GROUP	Dr.	PHOTOGRAPHS TAKEN (DATES)			
	Dr.	R. Profile			
		L. Profile			
		Full Face			
DIAGNOSIS: -Here it is stated whether the malocclusion is inherited or acquired, or partly inherited and partly acquired. Also the probable cause of the condition.		RADIOGRAPHS TAKEN (DATES)			
PROGNOSIS: -Depends upon the diagnosis. Acquired conditions readily respond to treatment. Inherited conditions are difficult to treat, and retention is not possible.		Series			
		R. Lat.			
		L. Lat.			
		Hands Feet			
IMPRESSIONS		APPLIANCES			
DATE TAKEN	TAKEN BY	DATE MADE	MADE BY	INSERTED BY	

Fig. 28.—History chart used in Orthodontic Clinic at the Hospital for Joint Diseases.

critical periods are also partly inherited, but in such instances the prognosis should be considered favorable, especially if the symptoms of feebleness are well defined.

The third division contains the history of the patient. This is subdivided into (1) past history of patient, (2) general history of patient, (3) habits, (4) nose and throat, (5) muscles of mastication, (6) symptoms of feebleness, (7) calcification.

The past history of the patient contains an arbitrary list of diseases arranged in tabular form, and during questioning a mark is to be made in the proper

age column opposite the diseases which were contracted. The critical periods are indicated by heavier lines in the table, so that it will be seen at a glance which diseases were operative during that time. Several diseases may have been contracted during the critical period, and depending on their number, duration, and intensity, the probable effect on growth is estimated. It is important to note the duration of the disease, for which a special column is provided. The

HISTORY OF MOTHER		OCCUSION	CLASS				CALCIFICATION	
			I	II		III		
			1	2				
No. of Pregnancies	(previous to patient)	Patient					Carpals	
No. of Miscarriages		Mother					Epiphysis of Radius	
Diseases During Pregnancies		Father					Epiphysis of Ulna	
		Sisters					Styloid Process	
							Sesamoid of Thumb	
							Union of Ep. Phalanges	
							Union of Ep. Met. Carp.	
Fatigue		Brothers					Union of Ep. Ulna	
Constipation							Union of Ep. Radius	
Vomiting								
Duties								
Any other information		Relatives (Blood)					As compared with Dr. Clinton Howard's averages	

PAST HISTORY OF PATIENT	DURATION	AGE														GENERAL HISTORY OF PATIENT		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Whooping Cough																Birth	Normal	Malformed Teeth
Measles																	Instrument	Supernumeraries
Scarlet Fever																	Breast Fed	Ret. Deciduous Teeth
Diphtheria																	Bottle Fed	Early Loss of Dec. Teeth
Pneumonia																	Pacifiers	Loss of Permanent Teeth
Picusis																	Missing Teeth	Walked at Age of
Mumps																	Impacted Teeth	Talked at Age of
Chicken Pox																		
Asthma																	HABITS	NOSE AND THROAT
Bronchitis																	Sucking	Tonsils
Diabetes																		Adenoids
Enteritis																	Biting	Deflected Septum
Typhoid																		Breathing
Tuberculosis																	Pressurer	Nasal
Poliomyelitis																		Mouth
Tonsillitis																		Catarrh
Any other information																	MUSCLES	SYMPTOMS OF FEEBLENESS
																	Internal Pterygoid	Flat Feet
																	External Pterygoid	Knock Knees
																	Masseter	Bow Legs
																	Temporal	Round Back
																	Digastric	Protuberant Abdomen
																	Milohyoid	Moist Hands

Fig. 29.—Reverse side of chart shown in Fig. 28.

intensity of the disease may be mild, moderate or severe, and it is convenient to use a small open circle to indicate a mild condition. An open circle with a line crossing it and a blackened circle may be used to indicate moderate and severe diseases respectively. The first year of life is marked off by two heavy lines, because severe diseases occurring at such an early age must have a far-reaching effect. The interval between two and six years of age is also marked by heavy lines, indicating a vulnerable period. As the child grows older, the vulnerability to injurious influences is diminished; and the later in life the

diseases occur, the less likely it is that the development of the jaws will be affected by them. The most important effect of severe diseases occurring after the sixth or seventh year is the retardation of the vertical growth of the face, for, as it will be remembered, the maximum rate of growth of the face height begins at six years of age and continues at that rate until the age of twelve years is reached. This may result in the development of a deep overbite; not because of the lack of vertical growth, but on account of the altered reaction of bone to functional pressure, in accordance with the pressure-growth curves of Jansen. In such cases the enfeebled alveolar bones are not able to withstand the forces of mastication, and as a result the posterior teeth are depressed. Cases showing severe illnesses in early childhood should be looked upon as being caused by injurious influences, always bearing in mind the probability of the hereditary factor; the presence of which may be determined from the other divisions of the history.

The general history of the patient contains such other information as may be of interest to the orthodontist. It is generally believed that the method of early feeding (breast or bottle) and the use of pacifiers are instrumental in the formation of certain conditions of malocclusion. For research purposes these are also included in the chart, but the other factors listed in this subdivision are far more important, for they represent, in a great measure, the local causes of malocclusions. They have no relation to the feebleness of growth.

Habits are extremely important, and they must be carefully studied. They may cause typical malocclusions (typical for the habit), and they are always acquired.

The condition of the nose and throat is of more than passing interest. Enlarged tonsils and adenoids were, and still are, held responsible for certain types of malocclusions. According to Jansen, however, the same factors which are responsible for the feebleness of growth in other parts of the body are also responsible for exuberant adenoid growth. For purposes of research the condition of the nasal passages should be carefully noted. It is possible that enlarged tonsils and adenoids are purely local affections, but it is equally probable that they are caused by other injurious influences of a general nature. Only after a large number of cases are examined and are found to be associated with the symptoms of the feebleness of growth, can this question be settled. For the present, enlarged tonsils and adenoids must be regarded as purely local affections.

The muscles of mastication may be injured as a result of accident or diseases of the motor nerves. It is important to note these conditions, for the success or failure of orthodontic treatment depends upon their presence. When the muscles of mastication are involved, the prognosis is always unfavorable.

The symptoms of the feebleness of growth confirm the influence of general injurious agents, provided the disease or any other nocivity occurred at a sufficiently early age. It cannot be admitted that general injurious influences can cause malformations without corresponding symptoms in other parts of the body. Therefore, in addition to the occurrence of the disease the symptoms of the feebleness of growth must be recognizable before a case can be classed as one

caused by general injurious influences. Unless these symptoms are present, the nocive agent could not have been of sufficient intensity to cause the malocclusion.

A further check on acquired malocclusions may be obtained through the study of the calcification of the bones of the hand. The twenty-eight centers which calcify at successively different periods indicate normal or retarded growth. The work of Clinton Howard may be used as a basis of comparison. Retarded calcification is very likely associated with feebleness of growth; although the opinion prevails that it is of endocrine origin. The relationship here is not quite clear, but it is certain that retarded calcification is a result of some deleterious influence, and therefore it is acquired.

Thus the arrangement of the history charts aids in the diagnosis of the etiology of malocclusion. The second part of the history gives the first suggestion of an inherited condition; although any other condition which is not repeated in the family and which is not associated with early diseases of the child or mother, in the absence of local influences without the symptoms of the feebleness of growth, is classed as an inherited condition, provided, of course, that the calcification is normal. If the calcification is not normal, then the cause of such cases may be of nutritive or endocrine origin. But whenever early diseases enter into the history, or whenever the mother's condition during pregnancy indicates an interference with development, the case is classed as an acquired condition, which must be confirmed by the presence of the symptoms of the feebleness of growth, and retarded calcification.

When the malocclusion is caused purely by local influences, the symptoms of the feebleness of growth are not present, and the condition can be explained by the disturbance of the intraalveolar forces, the presence of habits or the affections of the muscles of mastication. Local causes, however, may be present as additions to the more general causes, and in such instances the symptoms of the feebleness of growth, and retardation of calcification are also present. If the malocclusion is not caused by general agencies, and if the whole extent of the deformity is not explainable in terms of the local causes present, then the condition is inherited and is complicated by acquired conditions caused by the local influences.

The response to orthodontic treatment depends upon the etiology of the malocclusion. Acquired conditions respond to treatment more readily than inherited conditions. In general, difficulties in treatment may arise (1) in all inherited malocclusions; (2) in all malocclusions in which the required tooth movements are in an opposite direction to the normal tendencies of the teeth to be moved by appliances.

The difficulties encountered in the treatment of inherited malocclusions are easily explained by Jansen's pressure-growth curves. Normal bone is less responsive to changes in pressure, and it has a lower fatigability. Therefore the tooth movement is slower in response to mechanical stimulation, although it will take place as directed. When the required tooth movements are in an opposite direction to the normal tendencies to the teeth to be moved by the appliances, the problem of anchorage should be very carefully studied; otherwise the desired tooth movements will not take place. The distal movement of the first

permanent molar is an extremely difficult tooth movement to perform; although it is a simple matter to move that tooth mesially, which is the direction of its normal tendency.

The difficulties arising during treatment may be gradually overcome, but that in itself does not constitute complete orthodontic treatment. After the teeth are moved to their normal position, it is further required that they maintain that position. Frequently they return to their original position, and even after several attempts they persistently return. The explanation for this is found in the etiology of malocclusion. If the malocclusion is due to injurious influences, the deformity will change readily under mechanical stimulation toward the predetermined form, and the case can be brought to a successful termination *if the predetermined form is normal*. Inherited malocclusions represent *abnormal predetermined forms*, and attempts to change this toward normality would involve a deviation from the forms and relationships which may have developed under the most ideal conditions. And it must always be remembered that *an alteration of the form predetermined by inheritance cannot persist*.

(To be continued.)

## THE BIOLOGIC PHASE OF ORTHODONTIA

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THE term biologic as it is found in orthodontic literature is used in a very broad and flexible sense. It refers not only to the actual subject of biology, although it includes this science, but to all those subjects which are not directly concerned with the mechanical phase of orthodontia. If the discussion does not deal directly with appliances or mechanics, it is referred to as the biologic phase. Thus we find the word biologic expanded to include embryology, histology, and physiology, as well as those sciences which deal with growth in any of its various angles, such as the biochemistry of nutrition and endocrinology. The realization of a need for means by which to measure this growth has brought forth a number of methods which have drawn on the resources of the anthropologist, including biometry, cephalometry, etc. The necessity for a knowledge of habits and their correction as well as problems of management of difficult types of children have brought the psychologist to the assistance of the orthodontist. So it is that the term biologic as used in orthodontic literature denotes those sciences which deal with the teeth and jaws as living tissue in contrast with those which deal with them as problems of mechanics.

The trend of modern American writers has been quite definitely toward a concept which gives a larger place to this phase, and it might appear that the orthodontists had but recently become conscious of its importance. A search of orthodontia history does not bear us out in this conclusion, and we find that as early as 1839 a French dentist recorded his observations regarding the biologic causes of malocclusion. Le Foulon recognized at this early date that the occlusion of the teeth was affected by many influences which were not localized in the mouth but which were indirectly responsible for the abnormal conditions which he saw. Children from certain geographical areas, as well as the members of the lower social and economic groups, were observed to be more susceptible to malocclusion than others. The prenatal condition of the mother was cited by Le Foulon as a contributing cause in cases in which an unfavorable history was followed by disturbances in the dentition. This keen observer also noted malocclusion in patients suffering from certain diseases—he mentioned scrofula, which was very prevalent, as one example. Abnormal tongue pressure was also included in his list of indirect biologic influences, which was rather complete when it is remembered that it was compiled nearly one hundred years ago.

### HEREDITY

There is probably no more widely discussed or more controversial question than that which concerns the rôle of heredity in the causation of malocclusion;

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and, while the present knowledge of the subject is insufficient to permit of its final solution, nevertheless some expression of opinion regarding it is essential to any consideration of the biologic factor in orthodontia.

The active discussion of heredity goes back to 1828 when J. C. F. Maurey stated that heredity and not rickets was one of the principal causes of malocclusion. Authorities since that time have taken positive stands on both sides of the question. Edward A. Angle refused to accept heredity as a cause of malocclusion and stated that nature never transmits the abnormal. This statement needs some qualification in view of more modern studies which prove that nature does transmit hemophilia, polydactylism, color blindness, and other characteristics which cannot be considered normal. The late Martin Dewey classified etiologic factors into hereditary, congenital and acquired, stating that predisposing causes, such as supernumerary teeth, missing teeth, anomalies of morphology, lowered vitality, etc., are inherited and not malocclusion as such.

Brash states, "There is an evolutionary background to the problem implying selection and heredity of variations in the marked reduction of the face and jaws relative to the skull which has occurred; the alveolar element of the jaws has been reduced more than the basal, and there has been a reduction in the number and relative size of the teeth, but not to such an extent."

It is a generally accepted principal of genetics that the somatic and germinal cells are separate and distinct and that any acquired change in the somatic cells of an individual cannot be transmitted directly to offspring. Biologists also agree that all strictly hereditary factors are determined at the time of conception. Consequently when we see anomalies repeating in families and in successive generations, it must be attributed to the above causes or a similarity in environment rather than to direct inheritance of malocclusion.

A very convenient theory and one which has been discredited and revived by turns is that which claims that teeth are inherited as a unit from one parent and the jaws from the other. This theory has been given a more modern interpretation by DeVries (*Int. J. Orth.*, February, 1933) in which he calls attention to the fact that the bone and teeth germs are derived from different germ layers and consequently might result in some "disharmony of relationship." If this theory were carried to its logical conclusion we should expect to find "disharmonies" between the enamel and the cementum, etc., as they too are derived from different germ layers. It is probable that some explanation similar to that suggested by Brash will be found to be more the truth than the above theory in any of its forms.

Whatever theory we accept regarding heredity as a causative factor of malocclusion, it is of interest principally as it affects prognosis and places limitations upon our chances of successful treatment. Before the discovery of the microscope, the zygote was believed to contain the individual in miniature and to increase in size without regard for differentiation. The modern compound microscope revealed that the undifferentiated cells of the zygote were not the miniature but, as Angle said in speaking of the "line of occlusion," "they were the 'plan' of the individual."

If these cells developed through prenatal and postnatal life under ideal conditions, then the optimum individual normal would be attained and the

specifications of the plan would be satisfied. The individual might be above or below the average normal but would be the highest attainable from the given hereditary background. It is in the margin between actual and optimum that orthodontic as well as other corrective measures are effective, and it may be said that our chance of success will vary directly with its width. In other words, a person with good hereditary background but having been influenced by an unfavorable environment has a more favorable prognosis than an individual with poor inheritance and a more favorable environment.

#### CONGENITAL INFLUENCES

Much has been written regarding the prenatal influence in the etiology of malocclusion, but like many other such factors much of it is speculative and very difficult of proof. It has been demonstrated on the lower animals that toxic substances, such as alcohol and various drugs given during gestation, do show a harmful effect when compared with control animals. Instances have also been noted in human beings in which various toxemias have resulted in abnormalities, although few diseases are transmitted directly. A great deal of stress has been laid on prenatal feeding with special attention to mineral requirements, and, while this is undoubtedly good practice, it is beneficial principally to the mother as it has been demonstrated that the fetus will extract all that it requires from the mineral reserve unless the mother is actually approaching starvation. Brash mentions other factors, such as pressure from amniotic fluid, amniotic bands, and pressure points in the later stages of intrauterine development. It is reasonable to suppose that these and other influences may have an adverse effect upon development during prenatal life, but it is difficult to demonstrate direct cause and effect in a given instance.

Gross asymmetry of the cranial bones which is due to injuries at birth is often associated with malocclusion, and it has been suggested that this same trauma may be held as a predisposing cause of dental anomalies.

Both congenital factors and trauma at birth would have an adverse effect upon prognosis, since their influence would extend beyond the area affected by orthodontia treatment.

#### EMBRYOLOGY

If the orthodontist is to recognize the various anomalies of dental and facial development, he must have some understanding of how these structures were formed and the stages through which they have passed during embryonic life. It is necessary to realize that the progress from the single fertilized cell through the various stages of the germ layers to the highly specialized structures with which we deal, involves much more than simple growth. It is a process of development which Conklin defines as "a progressive and coordinated differentiation of the organism under the influence of heredity and environment."

The face and jaws, to which this discussion will be confined, are preformed very early in life. As early as during the third week the frontonasal process which later becomes the premaxilla and part of the nose is seen growing downward to meet the maxillary process of the mandibular arch, and by the fourth week these two processes are united and the arch of the upper jaw is formed.

At about the sixth week the dental lamina begins to appear as a thickening of epithelial cells which shortly give rise to the deciduous enamel organs.

The nose and the mouth are one cavity until the third month, when horizontal processes from the maxillary arch unite with each other and the premaxilla to form the roof of the mouth and palate. It is at this period that any interruption in the development will cause a failure of these parts to unite and a cleft palate will result.

Noyes calls attention to the fact that the formation of the fetal head at certain stages of development bears a marked resemblance to certain types of malocclusion as seen in later life and gives illustrations from Retzius which show decided protrusion and retraction of the mandible. It is suggested that any interruption in growth at certain periods of fetal life either from disturbances in nutrition or from other causes might so retard the development as to affect the shape of the jaws and thus predispose toward malocclusion. It is also pointed out that disturbances similar to those which cause cleft palate, etc., might, if less severe or in different location, cause other types of anomalies.

#### DEVELOPMENT OF TOOTH GERM

It is interesting to trace the histogenesis of the teeth from dental lamina to the permanent dentition; but, as this is a rather extensive subject and our space somewhat restricted, it will be possible to mention only a few of the salient features.

The studies of Logan and Kronfeld were made in order to discover certain facts relative to the surgical operation upon cleft palate, but many of their findings are of such importance to the orthodontist that they merit some attention. Their work which was done with sections from human specimens resulted in the discovery and correction of certain errors pertaining to the calcification and eruption of teeth as well as to the relative position of deciduous and permanent teeth during development.

In 1893 Legros and Magitot compiled a table of the calcification of the permanent teeth which has served as a model of similar tables in most textbooks since that date. This table gives the first month as the time of calcification for all permanent teeth, maxillary and mandibular, as far distal as the first permanent molar, which was placed at the sixth fetal month. They also assumed that the order of eruption coincided with the order of calcification.

Examination of Table I shows that most teeth calcify later than had been previously supposed, a discrepancy of  $1\frac{1}{2}$  to 2 years being noticed in the bicuspids. A marked difference occurs in the maxillary lateral incisors which do not calcify until 1 year to 15 months, as against 1 month in Legros and Magitot. It is also noticed that the order of calcification does not coincide with the order of eruption in this tooth, as it calcifies much later than the cuspid, although it erupts some two or more years earlier. Their microscopic findings are checked by observation on hypoplastic teeth which show wide areas on central incisors and cuspids but only slight nicks on the lateral incisors of the same arch. Logan and Kronfeld place considerable importance upon these facts and believe them to be significant from a phylogenetic stand-

point. It is believed that the late development of the lateral incisor and the fact that it is so often missing indicate that it is being eliminated by a process of evolution.

Refinements of technic using celloidin enable these workers to determine more accurately the position of the slightly calcified germs in the bony crypt and also to locate the germ of the permanent tooth at a much earlier stage than had previously been possible.

TABLE I

TYPE OF LOGAN AND KRONFELD TABLE. TIME OF BEGINNING CALCIFICATION OF THE PERMANENT TEETH

MAXILLARY TOOTH	LEGROS AND MAGITOT (REPRODUCED BY NOYES, BÖDECKER)	AUTHOR'S FINDINGS
1	1st month	3 to 6 months
2	1st month	1 year to 15 months
3	1st month	3 to 6 months
4	1st month	1½ to 2 years
5	1st month	2 to 2½ years
6	6th (fetal) month	1 to 4 months
7	3rd year	2 to 2½ years
8	12th year	7 to 9 years
MANDIBULAR TOOTH		
1	1st month	3 to 6 months
2	1st month	3 to 6 months
3	1st month	3 to 6 months
4	1st month	1½ to 2 years
5	1st month	2 to 2½ years
6	6th (fetal) month	1 to 4 months
7	3rd year	2 to 2½ years
8	12th year	7 to 9 years

Diagrams in most texts depict the developing germ of the permanent tooth connected by a strand of epithelial cells to the lingual of and slightly apical to the deciduous crown. Logan and Kronfeld show early specimens in which the permanent germ is in a position occlusal to the deciduous crown, and they trace its progress as it moves lingually and apically to a point above or below the deciduous root. The maxillary cuspid crown makes a very long circuit to a point directly over the first bicuspid germ and lies high in the angle between the nasal cavity and the maxillary sinus. A correct understanding of the normal in the developing tooth germ is a material aid in recognizing the abnormal as it is met in the various types of malocclusion.

#### BONE GROWTH

##### *History*

The foundation of all orthodontic as well as orthopedic procedure is to be found in the fact that bone is a living tissue. It is in fact defined as connective tissue whose intercellular substance is calcified and arranged in layers around nutrient canals and spaces. Previous to 1736 bone was known as "ossifying matter" which continued to grow harder with age until ossification was complete and growth ceased. (Chesseldon.) In the summer of the above year Belchier discovered accidentally the process of vital staining by madder feeding, thus opening the way for Duhamel to perform his famous experiments which led to the discovery of the principles of bone growth. The works of

Duhamel and Haller and later by Hunter and Goodsir form one of the most interesting chapters in medical history. By alternately feeding and withholding madder, Duhamel discovered that bone is formed in layers under the periosteum which he believed to be its source. He also measured growth in the length of bones by applying pegs in the shafts of growing femurs and observing the spacing after a period of growth. This method proved to him that most of the growth took place at the ends in the epiphyseal areas, since there was no appreciable growth between the pegs.

It remained for Hunter to discover that bone growth consisted of two processes, deposition and absorption, although he believed that the arteries were actively responsible for both processes. The discovery of the compound microscope enabled Goodsir, who was a contemporary of Hunter, to evolve the cell theory of bone growth and to demonstrate the activity of the osteoblasts.

The conclusions of these early investigators were remarkably sound when we consider the methods at their disposal, and they have served as a basis for all subsequent discovery in this field.

The formation and the growth of bone are of such vital importance in orthodontia that some knowledge of the subject and its special application to the development of the teeth and jaws is necessary.

Most bones of the skeleton are preformed in cartilage and at birth consist mainly of this material with calcification starting at the various centers. As calcification progresses, osteoblasts form on the surface of the perichondrium while osteoclasts cut into the cartilage at various points until the bone is substituted for cartilage. This process is known as endochondral formation. The mandible is a notable exception in the manner in which calcification takes place, as it develops by endomembranous formation, in which the connective tissue cells surrounding Meckel's cartilage differentiate into osteoblasts and deposit the bone in layers on either side of the tooth germ.

When a bone has been formed, its increase in size, as well as the changes due to stress, takes place in the following manner.

The periosteum is the tough fibrous coat which affords protection and contains in its inner layer the osteoblasts or osteogenic cells. These cells deposit the outer layer or subperiosteal zone which is laminated and quite dense with bone corpuscles and their canaliculi distributed throughout its substance. As more layers are added from without, the inner layers undergo absorption by the large multinucleated cells known as osteoclasts. Spaces begin to appear and later coalesce to form a system of anastomosing haversian canals. The corpuscles are arranged in concentric layers around these canals and form with them a network of living protoplasm throughout the substance of the "compact" bone. Still more absorption by the osteoclasts cuts into this layer until in the cancellous layers the calcified material is reduced to a series of delicate spicules within the marrow cavity.

Nature is not always economical in the use of her building material, and more bone is deposited than is needed for strength. The order of the above process is then reversed, and the excess is removed from areas in which it is not needed. Both processes are constantly at work, especially in growing individuals, in accordance with functional stresses and requirements for greater

strength or larger area. Both osteoblasts and osteoclasts are in a state of constant transition, appearing in active centers when they are needed and disappearing when their work is finished.

The jaw bones are governed in a general way by the same laws of growth as other long and flat bones but have certain additional features which are peculiar to themselves. The active osteogenic areas in the long bones are in this periosteum at the epiphyses and to some extent in the walls of haversian canals; while these centers are active in the jaws, they have in addition the activity associated with the development of the teeth. The peridental membrane contains osteogenic cells in addition to its cementoblastic layer and is actively laying down bone to keep pace with the external growth. The follicle wall of the permanent germ which later becomes the peridental membrane is in a constant state of oscillation between building and absorbing during the process of eruption. In fact the jaw of the growing child is literally packed with structures which have the power to grow new bone, and it is for this reason that the function which guides and molds this activity should be established in the normal as early as possible. Aside from being more plastic at an early age, there is another important reason why orthodontic treatment should be instituted early. The osteoblasts actually change in character after the cessation of active growth, becoming few in number and flattened in form; and, although it is possible to reestablish the oscillation by mechanical stimulation, as claimed by Oppenheim in his current articles, it is a distinct advantage to work during periods of active natural growth.

#### CALCIUM METABOLISM

Although bone is actually connective tissue, its bulk is composed of calcified substance which is deposited in its intercellular space in the form of mineral salts. Exact methods of analysis reveal the salts of several minerals in the bones as well as other tissue; iron, copper, manganese, zinc, aluminum, fluorine, sodium, and potassium are present in small amounts as well as the two principal elements, phosphorus and calcium. The last named mineral, calcium, is found in the bony tissues and in the blood as phosphate and carbonate and plays a very important part in the body chemistry. Besides its function of bone building, calcium is a controlling factor in the coagulation of the blood, and it is important in certain healing processes as in tuberculosis. Berman and others have observed a relation between disturbances in calcium metabolism and various neurotic symptoms in children, as spasmophilia. Strang believes that certain typical cases of infraversion are associated with deficiencies in the calcium assimilated.

Since calcium is such a vital element in the growth of bone as well as other tissues, it may be interesting to examine its source and the process by which it is made available for its various functions. The main source of supply of calcium in the diet is from milk and green vegetables, such as spinach and lettuce, and these should form part of the diet of every growing child.

When it has been assimilated from the food, the calcium is taken up by the blood stream where it is held in highly concentrated solution by a chemical process which is not yet understood. As more calcium is assimilated than is

needed to supply current demands, it is carried to the bone marrow where it is fixed and held in storage. This excess is available as a reserve supply in case it is needed and is released through the action of the parathyroid hormone and carried to the desired location by the blood stream. Mineral salts are not precipitated directly to the matrix but are first acted upon by an enzyme, phosphatase, which has been secreted by the osteoblasts and which has the power to precipitate serumal calcium. The above outline is in simple terms, but the mechanism involved in the assimilation and metabolism of calcium in all its ramifications is a very intricate and delicately balanced biochemical process.

#### SUMMARY

The foregoing résumé is not presented as a comprehensive review of all the so-called biologic phases of orthodontia, but an attempt has been made to review some of the more important historical facts as well as some of the new developments and also to state some of the arguments on certain controversial matters.

The studies in biometry and facial growth have not been touched upon, nor have the subject of habits, nutrition, or endocrinology been discussed, as any of these subjects would demand separate treatment.

The interest of orthodontists seems to be focused upon this biologic phase, and it is probable that future progress in the science will come from investigation in this field.

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## A HEAD POSITIONER FOR SCIENTIFIC RADIOGRAPHIC AND PHOTOGRAPHIC PURPOSES

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THE head positioner which is to be described has been developed in an attempt to place in the hands of the dentist, especially the orthodontist and the prosthodontist, a scientific method of obtaining accurate radiographs and photographs. Because of the large amount of space required and the cost of the equipment, the apparatus and methods formerly used were left to those conducting research. It is hoped that, as a description is given of the equipment and the methods used, these objections will be eliminated.

The equipment needed for taking the various types of radiographs and photographs is as follows:

1. X-ray machine. The dental type is sufficient, although a higher milliamperage is desirable for certain exposures. For scientific research a stationary x-ray tube is generally used in order to be assured of a constant focus, but for practical use the methods described will be seen to be as accurate as necessary.
2. Camera. Any good make, equipped for close photography.
3. Revolving chair, adjustable for height; a dental chair or some less expensive substitute.
4. Head positioner with cassette holder.
5. X-ray tube positioner.

Naturally, the only parts of this equipment that need further explanation are the head positioner with cassette holder and the tube positioner.

### THE HEAD POSITIONER WITH CASSETTE HOLDER AND SUSPENSION BASE

*The suspension base.*—Since the support suspends this head positioner from the ceiling, it is out of the operator's way when it is necessary to use it over the dental chair rather than to have a separate room for radiographic and photographic exposures.

The suspension base, *a*, from which the head positioner hangs is securely fastened with screws to an oak block, *a'*, Fig. 1, which in turn is fastened in like manner to the ceiling. The lower end of the base, *a*, is a hollow tube, ending in an inner threaded section into which a smaller, threaded hollow tube section, *c*, is turned. The threads of this allow for a vertical adjustment of the head positioner equal to about six inches. This small threaded section, *c*, terminates below into a smooth unthreaded portion with a slot, *d*. (Fig. 2.)

*The upper portion of the head positioner, its means of attachment and stabilization in the suspension base.*—The upper portion of the head positioner is a solid steel shaft, *e*, Fig. 2, the upper end of which fits accurately into the hollow cylinder, *c*. A long bolt, *f*, which turns completely through a threaded opening

in the shaft, *e*, extends and fits into the slot, *d*, provided for it. By tightening the bolt, *f*, after placing the head positioner in its suspension base, it becomes stabilized at that point. The entire head positioner may still be raised or lowered through the six-inch range previously mentioned to allow for focusing when a stationary tube is used, after which the key, *g*, is tightened and the head positioner is fixed in its support.

When placed in its support, the lowest point of the head positioner is from fifty-four to sixty inches from the floor, a convenient height for the operator.

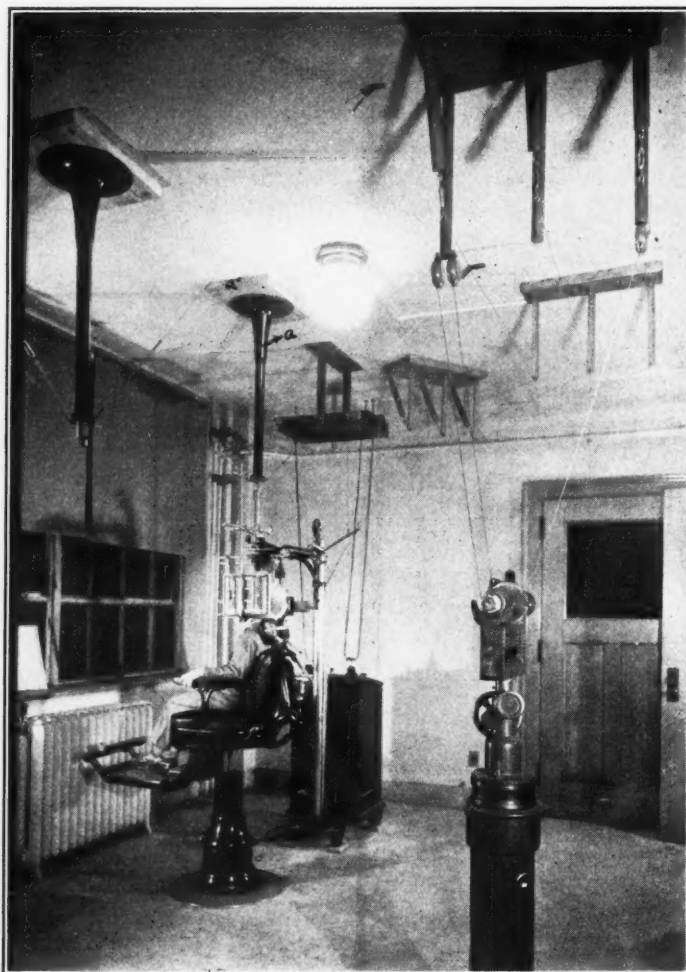


Fig. 1.—Research room showing ceiling support and positioner above the dental chair.

When the head positioner, itself twenty-one inches in length, is removed from the support, the lowest point of the suspension base is at least seventy-five inches from the floor. Since the head positioner can be removed from and replaced into the suspension base in a moment's time without losing any established relationships, it is easily understood how the positioner can be used above the operating chair.

*The lower adjustable portion of the head holder.*—The principle of the adjustable portion of this new head positioner as well as of the positioner I first

used in conjunction with Spidel<sup>1, 2</sup> is based upon the Simon<sup>3</sup> method of taking impressions. That is to say, the head is oriented on the Frankfort plane by means of ear rods which enter the ear holes, and of a pointer which locates the deepest portion of the lower border of the bony orbit, or the point on this border exactly below the pupil of the eye when the patient is looking at an object some distance away directly in front of and on a line with the eyes. The same principle of head orientation is used in the head holder designed by

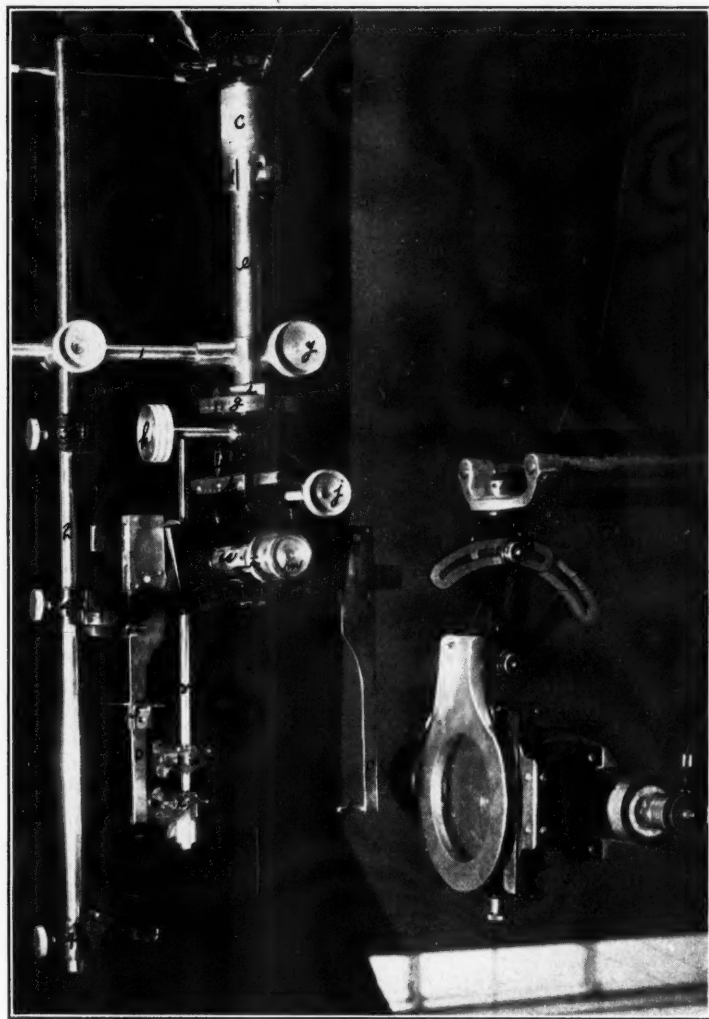


Fig. 2.—Close-up view of head positioner and cassette holder.

Broadbent<sup>4</sup> to whom we are all indebted for many contributions to our present knowledge of growth and development of the head because of his pioneer work in this field of x-ray application to the study.

This head positioner is unlike others of which I know in that it has additional adjustments which make it useful for all types of scientific radiographic and photographic procedures on the head, as follows:

1. The portion of the head positioner below the calibrated disk, *g*, can be rotated through part or all of the entire 360° in the horizontal plane when

released by turning the knob, *h*. A marker, *i*, indicates the amount of rotation used for any given picture. Because of this feature of being able to rotate the head holder only one x-ray tube is necessary for anteroposterior or both profiles even though a stationary tube or a tube positioner is used. In like manner, it also eliminates moving the camera in photographic work.

2. By turning the handle, *j*, the head positioner may be moved forward or backward the amount necessary to produce stereoscopic radiographs where desired. A calibrated plate, *k*, provided with a zero marker, *l*, serves to indicate the amount of movement produced.

3. Contained within the nearly rectangular shaped portion below the sliding device, for anteroposterior movement and directly above the space allowed for the head, is a ratchet wheel effect which by turning the knob, *m*, carries the two arms, *o-o'*, equipped with the ear rods *p-p'*, at their lower extremity, toward each other simultaneously, while the upper portions of these arms, *q-q'*, emerge and travel in opposite directions away from each other. This is a very convenient arrangement, since, in a single and easy operation, the ear rods are caused to enter the ear holes an equal distance, thus automatically centering the head. Calibrations on the arm portion designated as *q* give a reading as to the amount of penetration of the ear rods into the ears by indicating the distance between their tips.

4. The rather large slot, *s*, allows for tipping the head laterally by movement of the arms, *o-o'*, toward either side, through the arch of a circle, when freed by turning the knob, *t*. Calibrations along the lower edge of the slot serve to indicate the amount of lateral tipping of the head.

In addition to the provisions for the adjustments just described we find projecting from this same rectangular portion, but on the opposite side, a rod, *u* (not shown in the picture), with a smaller one, *v*, directed downward at right angles to it. On this smaller rod we see three devices. The one nearest the top is a head stabilizer, *w*, with just below it an orbital pointer, *x*, to indicate the lowest point in the margin of the bony orbit and below both a fixation ring used to fix the orbital marker on the identical plane of the ear rods. All these are equipped with thumbscrews to secure them after adjusting to the proper position.

From the foregoing description, it can be seen that after the head is oriented on the Frankfort plane it can be:

1. Rotated in the horizontal plane.
2. Moved forward or backward.
3. Tipped to either side.

*The cassette holder.*—The cassette holder is completely adjustable. By releasing the knob, *y*, the entire holder can be raised or lowered along, and rotated around the shaft, *e*. The cassette holder consists of two solid steel rods, *1*, and *2*, at right angles to each other; and grooved attachments, *3*, and *4*, for holding the cassettes themselves. Any sized cassette may be used from the small occlusal type 2¼" × 3" to an 8" × 10" or larger.

The cassette holder allows the cassette to be moved toward the head or away from it, raised or lowered, and rotated to any position in the horizontal plane.

A small square, 5, attached to the arm of the head positioner is used to assure the cassette being in correct angulation with the x-ray beam.

#### THE X-RAY TUBE POSITIONER

If a dental x-ray machine is used rather than a stationary tube, the x-ray tube positioner, while not necessary for most pictures, is needed for the antero-posterior and profile views of the head for which a film target distance of five feet is recommended. (Fig. 3.)

The tube positioner may be a very simple device consisting of a metal ring which fits the cone of the dental x-ray unit and which may be suspended from the ceiling or swung from a wall bracket in such a manner as to place the cone

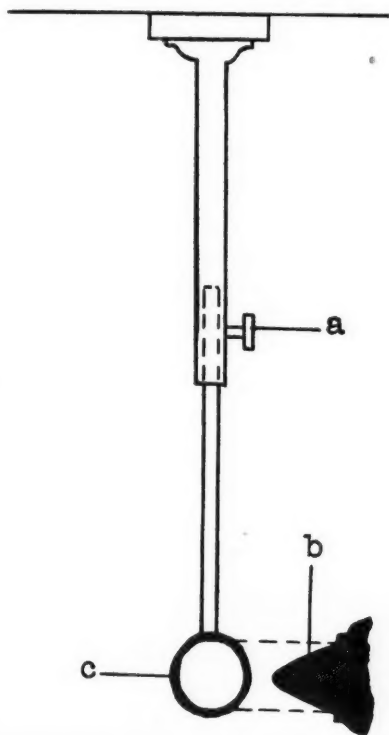


Fig. 3.—X-ray tube positioner. *a*, Knob for vertical adjustment. *b*, Cone of dental x-ray machine. *c*, Metal ring in which cone fits.

of the dental x-ray unit and thus the midcentral ray of the x-ray tube in focus or correct relationship to the head positioner. To bring the x-ray tube and head positioner into focus, the ear rods are removed from the head positioner, after which by sighting through the two openings simultaneously, the mid-point of the cone of the dental x-ray machine is caused to lie on the same plane and in the exact line of the ear rods. The tube positioner is then mounted by suspension from the ceiling or attachment to the wall in such a manner that when swung to position it will fit the cone of the x-ray machine in the position in which it is in focus. After these relations are established, no subsequent focusing is needed, although a check may be made occasionally, in the same manner as just described, to be sure the relationships are being accurately maintained.

For all other work the cone of the x-ray machine is placed where desired on one side of the head and the cassette positioned on the opposite side by means of the adjustable cassette holder. If a similar picture of the opposite side is desired, the head is retained in the same position, and the dental x-ray tube and cassette holder are shifted to the opposite side.

Such radiographs as profile and anteroposterior of the head are indispensable in the study of growth and development, and these, together with those of the temporomandibular articulation, are being recognized by the orthodontist and the prosthodontist as a valuable and essential aid for diagnosis and for checking results after treatment. Such radiographs, in order to be of value, must be taken in a systematic way with a definite and constant relation existing between the part to be x-rayed, the film, and the x-rays. What is equally important is the necessity of repositioning the head in such a manner that the exact relations secured for the first picture exist for all subsequent pictures on the same patient. All these requirements are met with this head positioner and cassette holder. In another article entitled, "A New and Scientific Method of Obtaining Radiographs of the Temporomandibular Articulation," I intend to explain how the desired radiographs may be readily produced with this new head positioner.

The design for this equipment was suggested by me, while the actual construction was accomplished by A. V. O'Brien, an instrument designer and professor in the department of engineering at the University of Iowa.

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## SOME FACTS AND OBSERVATIONS RELATED TO THE SOLDERING OF CHROME ALLOYS\*

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CHROME alloyed steels, although relatively new in the armamentarium of the orthodontist, have been known and used in the metal trades for the past two decades.

The probable reason for this difference in time of initial use may be due to two factors: first, that during the early years of the manufacture of chrome alloyed steels, the manufacturer was solely concerned with the adaptation of the new material to more general use and not to specialized use such as for the orthodontist; and, second, because the orthodontist did not appreciate its possibilities or properties, the most important of which are very high tensile strength associated with a modulus of resilience falling in the same range as that of gold, and resistance to stain and corrosion.

Today there are hundreds of different chrome alloyed steels, each possessing individual and characteristic properties. Ordinarily, a mention of chrome alloyed steel merely brings to mind a steel alloyed with a certain percentage of nickel and chromium. This is only partially true, for chrome alloyed steels may be more complex in formula than this, containing many other elements in varying percentages.

Although all the various alloys possess the faculty of resisting corrosion, they vary greatly as to other properties, such as tensile strength, elasticity, ductility, and resistance to intergranular corrosion after having been heated to working temperatures.

The common experience of most operators using this material has been that the alloy generally known as 18/8 stabilized steel is the most suitable for use in orthodontia. The 18/8 indicates the percentage of chromium and nickel respectively used in this alloy. A stabilized chrome alloyed steel is most generally one which has a low carbon content and contains titanium or columbium, in amounts equal to approximately five times the carbon content of the alloy. Stabilized steel is preferred because it will withstand better than straight 18/8 the higher temperatures with greater resistance to carbide precipitation and subsequent intergranular corrosion, a condition sometimes referred to as carbon spot formation.

Shortly after the introduction of chrome alloy into orthodontia, it became evident that certain factors must be closely controlled if its use was to be successful. Because of its nature, it reacted much differently when exposed to heat

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than did the gold alloys. This meant that it could not be soldered or handled at temperatures as high as those used with gold.

If this type of material is to be employed in the fabrication of orthodontic appliances utilizing a soldering technic, it is of utmost importance that the material used be able to withstand reasonable limits of temperature without being irretrievably damaged. Considering the fact that the modulus of resilience and tensile strength of chrome alloyed steel is lowered when the material is exposed to high temperatures and cannot be increased by subsequent heat treatment, we must determine the maximum temperature to which the material may be exposed without any appreciable deleterious effect and select a flux and solder which can be satisfactorily manipulated at this temperature.

The method selected to study the effect upon the material to be soldered, by the temperatures to which it would be subjected in a given soldering procedure, was an arbitrary bend test, the usual thermoelectric power method of analysis, and determinations of the tensile strengths of specimens in the critical range of temperatures. These data can then be compared with the temperatures at which the various solders flow, and conclusions can be drawn.

For the bend test a pair of knife edges were constructed so that there was a space of one inch between them. Each specimen was placed across these knife edges, and subjected to a bending stress of 250 grams, acting perpendicular to the axis of the specimen. The load was applied over a region of one-eighth inch at the midpoint between the knife edges. The deformation was measured by an Ames dial gauge graduated to  $\frac{1}{100}$  of a millimeter. The plunger of the gauge exerted a force of 65 grams on the specimen, but this has been considered as part of the zero reading, and assumed to be constant for each specimen. Each piece tested was one and one-half inches in length.

The sample was placed in a muffle furnace and held at the temperature indicated for three minutes, after which it was immediately quenched. We realize that such a treatment is more severe than would probably ever be encountered in practice, but any effect which might be produced would be brought to light by this type of treatment; whereas, if treatments more simulating actual practice were utilized, much more precise methods of measurement would need to be applied, with perhaps no net change in the ultimate conclusions.

TABLE I

SPECIMEN QUENCHED FROM	BEND PRODUCED BY 250 GRAMS	BEND AFTER REMOVAL OF LOAD	RECOVERY
600° C.	0.60 mm.	0.03 mm.	95%
700° C.	1.34 mm.	0.08 mm.	94%
800° C.	1.48 mm.	1.10 mm.	26%
900° C.	1.92 mm.	1.52 mm.	21%
1000° C.	13.52 mm.	12.30 mm.	9%

After this heat treatment the specimen was subjected to the bend test described above. The results of these tests appear in Table I. The first column in the table merely identifies the specimen; the second column gives the bend produced by the cross bending load of 250 grams; the next row of figures gives the deformation which persisted after the removal of the load; in the last column

there is listed the percentage of recovery in each case—this can arbitrarily be considered a measure of the ability of the material to resist permanent deformation. From these figures it can be seen that there is a change occurring between 700° C. and 800° C., and a second transformation has occurred between 900° C. and 1,000° C. A notation should be made with reference to the specimen which was quenched from 1,000° C. When the load was applied to this piece, it bent sufficiently to pass between the knife edges, so that the figures for this specimen are based upon calculations of the bend necessary to permit its slipping between the knife edges, and the measurement of the bent specimen after the test. Since it is quite likely that the full effect of the 250 grams might not have been realized, the value of 9 per cent is probably a bit high. Irrespective of this, however, a transformation is indicated to have occurred.

To determine more precisely at what temperatures these changes occur, a thermocouple was constructed of platinum and the chrome alloy which we used throughout the present work. By using a different chrome alloy, there perhaps would be a slight difference in the temperatures for which these changes are effected. For any stabilized chrome alloy of approximately the 18/8 variety, however, there would not be sufficient divergence from the values obtained to be of any practical significance.

A thermocouple constructed of the chrome alloy and platinum was connected to a galvanometer and the deflection noted for each 20° C. up to 700° C., after which the data were taken at each 10° C. The curve was obtained by plotting the temperature as a function of these data. The thermoelectric current, which is proportional to the galvanometer deflection, is dependent upon the difference in temperature between the hot and cold junctions of the thermocouple, and the difference in the physical characteristics of the wires of which the thermocouple is composed. Since we are plotting the temperature as a function of the current, any divergence from a perfectly regular curve must be due to a change in the relative difference between the platinum and the chrome alloy. The platinum will not be undergoing any polymorphic change, so that any such effect is due to a change in the chrome alloy itself.

TABLE II

TEMPERATURE RANGE	SLOPE OF CURVE
500° C. - 593° C.	45°
615° C. - 710° C.	43.5°
750° C. - 825° C.	37°
845° C. - 917° C.	36°

It was obvious that the second change which we observed in our bend tests, i.e., between 900° C. and 1,000° C., occurred at 990° C., because at this point the curve quite definitely changed its slope. The transformation which occurred between 700° C. and 800° C. was not quite so obvious. A careful analysis of the curve, however, does bring it out. The method used in this particular case was to measure the slope of the curve at temperatures below 710° C. and above 750° C. These temperatures were decided upon, since there appeared to be a slight discontinuity in this region. Referring to Table II, it can be seen that the rate of change in the slope of the curve is approxi-

mately the same on either side of the range 710° C.-740° C., but within this region a change has occurred since the rate of change here is almost three times as great as that found on either side of this temperature range.

In the determinations of the tensile strengths as affected by temperatures in this critical range, the specimens were subjected to the various temperatures for fifteen seconds and immediately quenched. The curve obtained by plotting the tensile strengths on the ordinate and the temperatures of treatment on the abscissa is shown in Fig. 1. It can be seen that the strength steadily drops throughout the range, but that this is minimized if the material can be manipulated below 750° C. A break in the curve between 720° C. and 750° C. perhaps indicates that the transformation has commenced at this lower temperature but that the short time of heating permitted but a part of the steel to undergo the transformation. Shorter times of heating also would in a similar manner reduce the effect at even the upper limit of 700° C.

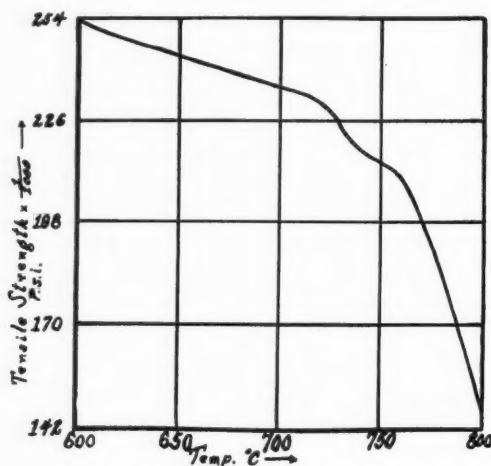


Fig. 1.

Therefore, so far as it is possible, we should stay below 720°-750° C., and it is essential that the chrome alloy at no time be subjected to temperatures in the neighborhood of 990° C., since at this temperature practically complete annealing occurs. The fact that the transformation indicated at 720°-750° C. takes place slowly should be noted. Because of this, we may, if necessary, heat the material to these temperatures, but precaution must be taken to use the lowest possible temperature for the shortest possible interval of time. The longer the material is maintained at these temperatures, the further transformation will progress; and likewise, the higher the temperature to which the material is heated, the more rapidly the effect will become appreciable. The ideal solder should flow readily below this temperature range, or in any case should not require temperatures much in excess of this, and should flow easily enough to permit rapid soldering.

Early attempts at soldering chrome alloy at temperatures ranging from 700° to 750° C. soon demonstrated the inefficiency of borax as a fluxing agent. Even when heated to the temperature at which it became fluid, borax did not satisfactorily wet the surface of the alloy, a prime requisite of any flux. Fluxes

of different formulas were tried with varying results. We have found that a mixture of 1 part of boric acid and 2 parts of potassium fluoride moistened to a pasty consistency with a liquid of about one part hydrochloric acid to five or six parts water gives a flux which is as satisfactory as any of the many fluxes which have been suggested for this work.

Photomicrographs of the soldered unions of chrome alloy showed no superficial alloying of solder and metal, but a sharp line of demarcation where solder and alloy came in contact with one another. This indicated that all dependence for strength in a solder union must be placed in the adherence of the solder to the metal. In the application of chrome alloy to orthodontia, many different solders have been tried; some were soon discarded as totally unsatisfactory, while others were found to satisfy the necessary requirements.

In the comparison of various solders as to their adaptability to a soldering procedure, we should consider them in the light of the three following aspects. First, we should have a soldered joint which will possess the greatest possible strength. Second, during the process of soldering, we should produce the minimum deleterious effect upon the physical properties of the appliance, especially with respect to the material's ability to resist permanent deformation; ideally, of course, the soldering temperature should have no effect upon the physical properties of the appliance. Third, the soldered joint should be resistant to corrosion and tarnish in the normal mouth. (Resistance to corrosion is absolutely essential, and consequently no solder considered in this paper will evidence corrosion in the mouth; and, in this respect, any of the solders will produce a satisfactory joint, provided a stabilized chrome alloy is used in the fabrication of the appliance.) We shall concern ourselves primarily with the question of which solder will produce the strongest joint and at the same time have the least effect upon the physical properties of the material being soldered by the temperature required in the particular soldering process.

The solders studied were two gold solders of 10 and 14 carat, Wipla solder type D.S., and an experimental solder which we shall refer to as X solder. The last mentioned solder has the following composition: silver—42 per cent; copper—31 per cent; zinc—20 per cent; cadmium—7 per cent.

For comparison of the strength of the joints produced by the various solders, simple butt joints were prepared and trimmed to approximately the same diameter as the wire which was soldered. These specimens were then pulled apart in a Baldwin-Southwark hydraulic testing machine.

The results of these tests showed that the 14 carat solder was so far inferior to the 10 carat solder that it can be discarded in this type of work. Further inspection of the data showed an enormous variation in the values obtained for the tensile strengths. In the case of the 10 carat gold solder, the values range all the way from 38,000 lb. per square inch to 87,500 lb. per square inch; for Wipla solder, from 39,600 lb. to 113,200 lb. per square inch; values from 77,500 lb. to 118,300 lb. per square inch appeared in the data for X solder. The wide range of values thus obtained amounts to from 20 to 37 times the experimental error present in their determinations and must, therefore, be due to unavoidable variations in soldering technic which are not completely under the control of the operator. This factor, so frequently referred

to as the personal equation, should be taken into account in comparing the materials. To compare the solders with consideration of this factor, it is necessary to determine the most probable strengths, rather than the arithmetical average as is usually done. Having obtained this, we should then consider the probability of achieving this value as well as the likelihood of realizing greater or lesser values than this most probable strength.

In order that the various solders may be qualitatively compared at a glance in this manner, the curves appearing in Table II were plotted. These curves are derived from the data by counting the number of values for the tensile strength which fall between 30,000 lb. and 40,000 lb. per square inch, and so on, for each 10,000 lb. square inch interval. These figures were then plotted as the ordinates and the corresponding strength ranges as the abscissae. The frequency values have all been reduced to a percentage basis. This facilitates

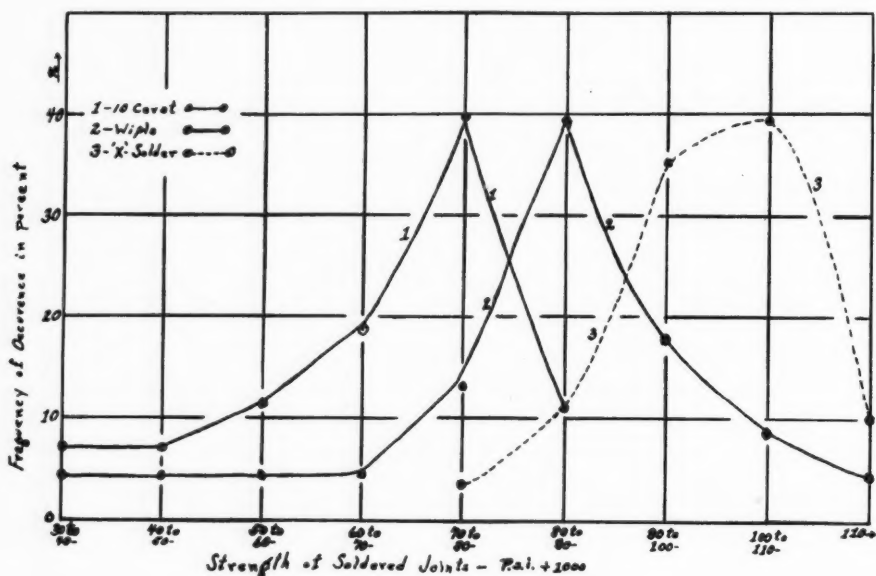


Fig. 2.

the comparison of the three solders, since the values are then all directly proportional, as they appear in the curves.

As can be seen from these curves (Fig. 2), the frequency of occurrences reaches its maximum value of approximately 39 per cent for all three of the solders. The most probable strengths are then given by the abscissae as follows: 70,000-80,000 lb. per square inch for the 10 carat; 80,000-90,000 lb. per square inch for the Wipla; and 100,000-110,000 lb. per square inch for the X solder. The probability is that about 39 per cent of the joints soldered will have strengths falling in these respective ranges. Further consideration must now be given to the remaining 61 per cent of the joints.

Let us first compare the Wipla with the 10 carat solder. The frequency of occurrence of the joints possessing a lesser strength than the most probable value is greater in the case of the 10 carat solder than would be expected for the Wipla soldered joints, as is shown by the difference in the distance from the abscissa to the curve in each case. The actual figures as calculated from our

data show that we may expect a joint which is weaker than the most probable value 47 per cent of the time in the case of the 10 carat solder, and only 30 per cent of the time in the case of the Wipla solder. In addition to this, we see that a good percentage of the Wipla soldered joints possessed greater strength than the most probable value; in fact, 30 per cent of the specimens are to be thus classified. Whereas, in the case of the 10 carat soldered samples, we found only about 13 per cent of the joints to be stronger than the most probable value. Adding the percentages together for the most probable strength and those which will exceed this value, we find that 76 per cent of the Wipla soldered joints will be 80,000 lb. per square inch or better, and only 52 per cent of the 10 carat soldered will have strengths of 70,000 lb. per square inch or better. A like analysis of the data for X solder shows that 50 per cent of the joints will be weaker than the most probable value, which falls between 100,000 and 110,000 lb. per square inch. It can be seen, however, that this curve does not indicate a sharp probable value as do the other solders, but rises rather rapidly for strengths from 90,000-100,000 lb. per square inch, after which the probability is fairly constant, until it again drops for the range of 110,000-120,000 lb. per square inch. We, therefore, are justified in considering this first range as part of the most probable values. Using this interpretation, we find that 83 per cent of the X soldered joints will be of the most probable value or greater—viz., will have strengths of 90,000 lb. per square inch or better. Of the remaining 17 per cent, only about 4 per cent will fall below the most probable value for Wipla solder, and in no case did we find values below the most probable value for the 10 carat solder. In other words, when using X solder, 96 per cent of the joints will have strengths equal to or greater than the most probable value for Wipla solder, and all of them will be as strong or stronger than any of the 10 carat joints. We may then conclude that the X solder is superior to the strength of the resulting soldered joint, and that the gold solder is inferior to either of the other materials as a solder for chrome alloy.

The melting points of the solders were determined by the standard wire method for the determination of melting points, as specified by the Bureau of Standards, in A.D.A. Specification No. 7, with the modification effected by omitting the 3 oz. weight, this being considered a more practical figure in this case than would be obtained by the standard test. The 10 carat solder melted at 750° C., the Wipla at 685° C., and the X solder at 690° C. The soldering temperatures were in excess of these melting points, however, and the following estimates based on the color of the work being soldered in the dark show that in soldering with 10 carat solder the temperature would be slightly in excess of 800° C., and for the other two solders, soldering was usually accomplished at temperatures around 750° C., or less. With respect to the soldering temperatures, the Wipla and the X solders are superior to the gold solder.

A comparison of the resistance of these solders to tarnishing was made by immersing polished specimens of the materials in saturated solutions of hydrogen sulphide for one week. The Wipla solder became very badly tarnished by the end of twenty-four hours, whereas the 10 carat solder and the X solder had not become sensibly discolored after one week's exposure. The Wipla solder is, accordingly, quite undesirable from the esthetic standpoint.

As the result of these data, we can conclude that of the solders used and studied, the X solder is superior to the gold solders and to Wipla, since it presents the operator with a greater probability of soldered joints of high tensile strength; it can be manipulated at temperatures which are at least as low as can be used with any other material; and it will not tarnish nor corrode in the normal mouth. Of the other two materials, the Wipla solder is superior to the gold materials in every respect except that it will tarnish badly in service.\*

Despite the fact that the X solder is unquestionably far from the ultimate in the future development of solders for chrome alloy, it may be employed with assurance that it will function satisfactorily, in any phase of appliance construction. Its use in the fabrication of many appliances during the past year and one-half has resulted in no greater amount of breakage than can reasonably be expected from any appliance placed in the mouth.

Before passing on to a detailed consideration of the soldering of chrome alloy, in the various phases of appliance construction, a brief review of the important factors in its management may elucidate some of the subsequent statements of this discussion.

#### TECHNIC REQUIREMENTS

1. *Intense Heat.*—The fulfillment of this factor can be satisfactorily achieved by means of a good orthodontic blowpipe using ordinary artificial bituminous gas and compressed air. A sharp-pointed flame, the inner cone of which is about an inch in height and with the air valved down just below the hissing point, has proved most satisfactory. All soldering must be done against a black background in order that the scale of temperatures used may be properly interpreted.

#### POUILLET'S SCALE OF TEMPERATURES

Incipient redness	525° C.
Dull red	700° C.
Cherry red	900° C.
Deep orange	1100° C.
White	1300° C.
Dazzling white	1500° C.

2. *Short Exposure.*—The optimum range of temperature for soldering chrome alloy is indicated by dull red or the temperature between 700° and 800° C. Using an intense flame, only a moment is required to heat the part to dull red; therefore great care must be exercised to avoid overheating. Experience soon enables the operator to translate these temperatures properly.

3. *Satisfactory Solder.*—This factor having been previously considered needs no future discussion.

4. *Proper Fluxing.*—The tendency for chrome alloy to oxidize readily when exposed to high temperatures necessitates careful fluxing of the parts to be soldered. The flux should be well triturated and should be smooth in texture to facilitate even and equal application. The even application of a flux, the

\*A new Wipla solder known as type W.U.E. is now on the market and has been found to give essentially the same results as the D.S. type with the advantage that the resistance to tarnish has been increased to a satisfactory level.

vehicle of which is water, onto the greaselike smooth surface of the alloy is sometimes difficult. This can be easily overcome by slightly warming the part just previous to its application.

5. *Rigid Apposition of Parts.*—In employing a low fusing solder and one that requires approximately a second's time in which to congeal after the withdrawal from the flame, it is highly important that no movement occur between the parts to be soldered if the maximum strength of the union is to be realized. Slight movement, while it may not produce immediate fracture, quite frequently is the causative factor in the separation of parts after the appliance has been inserted into the mouth. While the operator may prefer to cool the soldered union by means of cutting off the flame (as pinching the air hose, etc.), continued practice will soon develop the skill of withdrawing the parts from the flame without movement.

The purpose of this discussion is not to consider the application of the soldering of chrome alloy to any one particular type of appliance or system of treatment, but from a general viewpoint because some manner of rigid union of parts is necessary to all types of appliances, regardless of design. For convenience of discussion, the soldering operations necessary in the construction of any type of orthodontic appliance will be divided into four classes.

In this manner, reasons for the difficulties frequently encountered in the soldering of chrome alloy may be more closely examined.

#### SOLDERING OF BANDS

Chrome alloy lends itself admirably to the construction of orthodontic bands; therefore no modification of the technic generally used with other materials is necessary. After the band material has been tightly drawn around the tooth and pinched, the amount required for the band is cut off from stock, and the ends of the band are carefully fluxed and placed in apposition. The seam of the band is then placed into the flame and brought to a dull red, at which time the solder is quickly applied. If the temperature has been correct, the solder will quickly flow into the seam and firmly unite the ends of the band. Should the band need stretching, no hesitation need be exercised in gaining the needed additional circumference by hammering or thinning out the seam. Even though the thickness of a lap seam has been reduced to that of the remainder of the band, it will withstand the driving force necessary for the seating of the band.

A considerable amount of trouble can be avoided by routinely placing the seam of the band on the distolingual angle of the tooth. There it can be conveniently covered with tweezers, should it ever be necessary quickly to alter the position of either the lingual or the buccal attachment in the open flame. Where this is not done, the seam may be opened unintentionally, causing unnecessary work for the operator.

#### SOLDERING OF TUBES, BRACKETS AND OTHER ATTACHMENTS TO BANDS

This phase of soldering has given rise to much disappointment on the part of some operators who have attempted the use of chrome alloy in appliance construction. Many have thought that tubes or attachments made of

chrome alloy cannot be successfully soldered to bands made of the same material. The most frequent difficulty experienced in this respect has been the pulling away of the tube from the solder. Experience, however, has demonstrated that this breakage of appliance can be avoided, provided the proper technic is employed. Every attachment, whether a tube or a bracket, is subjected to more or less of a levering force exerted upon it by the engaging part; therefore provision must be made for the additional strength required in a solder union of this nature. This can easily be accomplished by simply roughening, grooving, or marking with the sharp edge of a file the area of the attachment to be covered with solder. Similar treatment of the band surface is unnecessary.

After the flux has been carefully placed on the parts to be soldered, the solder is applied to the smaller component. For example, when a buccal tube is to be attached to a band, flow the solder on the tube instead of the band, as is commonly done in the technic for other materials. The parts may then be brought into contact with one another, heat applied, and the union completed. An adequate amount of solder should be used to insure the filling in of all available space between the parts.

Because of the larger bulk of solder necessary for the soldering of buccal tubes to molar bands, these parts must be held in apposition for a slightly longer time than is necessary in other instances of soldering. Where this is not done, an incomplete fracture of the slowly congealing solder may occur, which in turn will result in a complete separation of parts at a future time.

Overheating of tubes should be avoided; otherwise scale formation will take place on the inside walls, reducing the diameter of the lumen and making the insertion of pin or arch-end difficult. Should this occur, the scale can be loosened with a drop of thin lubricating oil and then reamed out with a wire of suitable diameter.

#### SOLDERING PINS AND OTHER RIGID ATTACHMENTS TO THE ARCH WIRE

In soldering operations of this nature, the solder may be applied to either attachment or arch wire. The former method is preferred because the use of excess solder is avoided. In a majority of instances in which breakage does occur in unions of this type, the solder pulls away from the arch. This difficulty can be appreciably overcome by slightly roughening the arch wire in this area.

Observation has demonstrated that in unions of this nature, fracture is more frequently due to faulty appliance design than is commonly realized. Long before the introduction of chrome alloy to orthodontia, this type of breakage in an appliance was a common occurrence in the practice of many operators.

Owing to the fact that when breakage occurs, it takes place in the solder and not in the arch wire itself, repair requires merely the resoldering of parts instead of splicing or remaking the arch.

#### THE SOLDERING OF SPRINGS TO ARCH WIRES

In the use of chrome alloy steel, the soldering of springs to arch wires is the simplest of soldering operations to perform. The solder is applied to the arch wire in the same manner as in the technic employed when using other

materials. The arch and the solder are then heated until the solder is flowing easily, at which moment the spring is brought in contact with the arch wire and the whole is immediately withdrawn from the flame. If the operation is properly timed, no part of the spring, even that immediately adjacent to solder union, will be annealed. This obviates the necessity of winding or coiling the spring around the arch wire, a procedure indispensable to a technic which permits the annealing of the spring.

Operators in whose hands the use of chrome alloy has proved unsatisfactory may express surprise and disappointment over the fact that no new or radically different technic has been advocated.

Results of over three years of work with chrome alloy indicate that:

(1) Chrome alloy can be successfully soldered and is adaptable to any phase of appliance construction, provided the proper technic and materials are employed.

(2) Its use requires no extensive or special equipment.

(3) It should not be considered the ultimate in orthodontic materials but merely a step or niche in the development of the same.

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### PRINCIPLES PERTINENT TO THE RADIATION THERAPY OF ORAL CANCER WITH METHODS OF CALCULATING DOSAGE\*

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**S**URGERY is the oldest weapon of attack for cancer and for many types the most dependable. The use of x-ray and radium for the treatment of cancer is a more recent contribution, and for this reason a review of some of the principles entailed and the viewpoints regarded with favor at present is possibly of interest. Many of the changes in the treatment of cancer during the last quarter century have been brought about by this newer knowledge. After starting with considerable hesitation and at first by using only empirical methods, the gradual development of radiation therapy has now reached a point that allows a prescription of considerable accuracy.

#### CONCEPTIONS

Shortly after the beginning of x-ray therapy Bergonne and Tribondeau laid down the law that rapidly growing malignant tissue was more susceptible to radiation than normal tissue. In other words, that an adult differentiated tumor is more radioresistant than embryonal or more undifferentiated tumor cells. Later, in 1912, Lazarus-Barlow showed that cells in a state of active mitosis were less resistant to radiation than resting cells. These laws supplied the only basis for radiation therapy.

Almost a decade and a half ago Broders emphasized anew the importance of the degree of cellular differentiation so far as prognosis was concerned. Broders demonstrated that to a certain extent he could estimate the prognosis by taking into consideration the percentage of undifferentiated cells in the various groups. Some criticism of this conception was made immediately. Probably the most important was that this conception does not take into consideration the length of time the tumor has been present and the size of the growth. As a matter of fact, there is a tendency for the cellular picture to be more anaplastic as the size of the growth is increased. Soon it was noted

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\*This is the fifth article of a series upon the subject of malignancy in and about the oral cavity. All phases of the subject are to be included.

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that in certain types of tumors the more undifferentiated the tumor appeared, the more radiosensitive the tumor was; and, on the other hand, the more nearly the tumor assumed adult cellular characteristics, the more nearly the sensitivity approached that of normal tissue of a given cell type. Ewing, therefore, proposed the idea of estimating the relative radiosensitivity of tumors along lines somewhat similar to Broders' attempt to predict prognosis. When the cell of origin is taken into consideration—the most important factor in estimating radiosensitivity—this conception has now assumed a position of some practicality. Thus, the tumor pathologist now is able to predict to a certain extent the relative radiosensitivity of a growth after consideration of the cell of origin, the vascular structure, the character of the tumor bed, the type of intracellular stroma, the presence or absence of the signs of infection. He should also have some knowledge of the patient's general condition.

In 1921, Wood and Prime presented experimental evidence to show that so far as epidermoid carcinoma is concerned, a lethal dose of radiation is not delivered until 7 to 10 "threshold" erythema doses are given. At that time the amount of radiation ordinarily given was not that high. Soon methods of interstitial implantation with highly filtered implants were worked out. These implants when used alone or in conjunction with higher voltage x-ray in many instances allowed a lethal dosage to a given area to be prescribed with a fair degree of accuracy. Thus, it became evident that one of the most significant factors in radiation therapy, when a cure is contemplated, is the quantity of radiant energy which is given to each individual cell of a given neoplasm. In the calculation of the dosage, consideration of the distance, absorption, scattering, and so forth must be taken into consideration, as these factors necessarily alter the percentage of radiant energy that actually gets to a given tumor point. Besides these factors, the rate of administration, the treatment interval, the quality of radiation, and the reactions of the tumor bed are of importance and probably modify the effect of radiation on malignant cells. When a lethal quantity of radiant energy for the given type of cell is not delivered to that point in the neoplasm receiving the minimum dosage, a cure ordinarily is not to be expected.

Martin and Quimby have termed the dosage given to the malignant cell which receives the minimum as the "tissue dosage" for that particular neoplasm. It is necessary at all times to keep this idea in mind in cancer therapy, i.e., whether or not a lethal dose is delivered to the cells receiving the minimum amount of therapy.

Many of the neoplastic cells that one hopes to render nonviable by radiation are little if any more sensitive to radiation than normal cells having a similar origin. To kill such malignant cells by radiation methods without also destroying an amount of normal tissue incompatible with normal function or even the general health is a problem constantly to be faced.

Squamous cell carcinoma developing in the lip, the cheek, the floor of the mouth, or the anterior tongue has been shown by Martin and Quimby to require that dosage equivalent to 6 to 10 skin erythema doses. This amount of radiation must be delivered to such tumor tissue within ten to twenty days to be lethal. Apparently metastatic squamous cells in the lymph nodes have

an even higher radioresistance. Posterior to Waldeyer's ring in a region including the posterior tongue, the tonsil, the naso-, oro-, or hypo-pharynx, down to the ventricular folds of the larynx, the idea has been promulgated by Martin that, even though microscopically the appearance of the tumor might be about the same as squamous cell carcinoma in the anterior mouth, because of regional characteristics the tumor might be somewhat more radiosensitive. The idea, however, lacks definite confirmation. In the pharyngeal region a special type of tumor may occur—in about a proportion of 16 per cent) the transitional cell epithelioma (Ewing) or the lymphoepithelioma (Regaud) which is definitely radiosensitive and requires only from 2 to 4 skin erythema doses of radiation delivered within ten to twenty days to be lethal.

There are several limitations to radiation as a principle. The tolerance of normal tissue may not be sufficient to allow one to use doses large enough to overcome cancer, although fractionated doses may overcome this limitation partially. Another factor which handicaps one is that it has been shown that a dosage which kills most of the cells might not kill all the cells. For instance, Packard showed that in rat sarcoma a dosage of 1,450 R killed 10 per cent of the cells, a dosage of 1,950 R killed 50 per cent, but 1 per cent survived 3,500 R. There are certain uncontrollable factors which are unpredictable. Sometimes the cure results when less than a lethal dose is given. Sometimes a fibrosis pens up the cells, which ultimately start to grow again. After insufficient radiation subsequent radiation may be valueless, and the door may be closed to other forms of therapy. Thus, the radiologist cannot always predict the result of the therapy which handicaps him in his preliminary decision. In spite of the limitations of radiation therapy this method is being used extensively.

#### METHODS OF RADIATION

A brief outline of the methods of radiation in use is pertinent. Thus, radiation may be applied (1) from the outside at a distance by using radium or roentgen rays or both, (2) by burying radioactive foci within the tumor tissue (interstitial irradiation), (3) by using external irradiation and interstitial or external radiation or both plus surgical intervention at one time or another.

#### EXTERNAL RADIATION ALONE

In the external application of radiation, radium which delivers principally gamma rays and x-rays which emit waves of varying lengths, are used. One is sometimes used to supplement the other. The principles entailed are similar with some variation due to the shorter wave length.

#### *X-Ray Therapy*

The three principle methods of x-rays are: (1) large mass dosage given at one time or in one day; (2) the saturation technic of Pfahler in which each portal is rather quickly brought up to an erythema and subsequently radiation is added at short intervals over a period of several weeks taking into consideration the percentage of recovery; and (3) the fractionated dose of Coutard, in which a third or fourth of the erythema dose is given through

one portal each day for a period of three or four weeks. An intense skin exfoliation is caused. These particular types of treatment have different effects upon the tumor cells, the stroma, and the vascular elements. At the present time the relative effect of the various technics are being energetically studied, and, although much is unknown, considerable data of value have been accumulated.

*The German Mass Dose Technic.*—We may well take this method as the starting point of measured x-ray therapy. Coming to general attention soon after the close of the war, this method was the first to be used with the then new "high voltage" (200 KVP) equipment. It simply consisted of applying a much larger dosage of more penetrating radiation than had been employed up to that time, in an effort to destroy the tumor at a single sitting. It was soon discovered, however, that a lethal tumor dose could not be given in a single treatment without extensive and irreparable damage to adjacent, often vital tissues. Particularly in deep therapy the method has been practically abandoned.

*Pfahler's Saturation Technic.*—Almost coincident with general recognition of the danger and futility of the massive dose principle, there was a widespread employment of Pfahler's saturation technic. Based somewhat on Kingery's study of the relation of radiation time and tissue tolerance, the essential factor in Pfahler's system was the establishment of a definite rate at which the tissues had been observed to recover from the effects of radiation.

By the employment of this predetermined rate one could at any time estimate the amount of radiation still in the tissues. In actual practice the method consisted of delivering through each portal one full erythema dose within two or three treatments and then maintaining that total quantity in the tissues by periodic replacement of that portion of the dosage otherwise lost by tissue recovery. The chief criticism of this method has been that the total dosage has been too low. More recently, Pfahler has stated that he has very considerably increased the amount of total irradiation, at the same time continuing the saturation plan of therapy, with definitely better clinical results. A short time ago skin recovery was thought to vary 5 to 9 per cent daily. Now it is known that the recovery may be as high as 60 to 70 per cent during the first twenty-four hours. This means from a practical standpoint that when divided doses are given a much higher total amount of x-ray may be given.

*Coutard's Protracted Therapy.*—Undoubtedly the most revolutionary changes in roentgen therapy have followed a widening appreciation of the principles generally credited to Henri Coutard of the Curie Institute of Paris, an outgrowth of Regaud's experiences in radium therapy; Coutard has found that an amazingly high total dosage will be tolerated by normal tissues if a number of relatively small treatments are given at a low rate of intensity, i.e., not to exceed 5 r/min. So slow a rate of administration was apparently primarily due to the fact that Coutard has employed the heavy and somewhat inefficient filter of 2 mm. of zinc plus 3 mm. of aluminum plus 2 cm. of wood.

Coincident with the development of Coutard's technic considerable controversy arose as to the relative importance of the original intensity, filtration,

and voltage, but there is universal acceptance of the fact that the tissue will withstand a much higher total dosage if it be given by a divided dosage technic similar to Coutard's method of protracted therapy.

Heublein's method of continuous radiation is the extreme opposite of the old massive dose technic. It is of little interest so far as cancer in and about the face, mouth, and jaws is concerned.

In all but surface tumors and those of a relatively radiosensitive type, the tissue dose possible with external radiation alone, even after using cross-fire methods, is often insufficient to be lethal. Thus, ordinarily from 2.5 to 3 skin erythema doses and usually even less are all that is actually delivered to the tumor depth from external sources of radiation alone. Often, therefore, external radiation is used to induce growth restraint without the expectation of death of all the cancer cells unless the tumor is of a particularly radiosensitive type or the location is so superficial that adequate dosage seems feasible by this method alone.

One of the most important problems for the x-ray therapist to determine in the future is whether or not the use of higher voltage and thicker filters will increase the number of cures. Some men have said that by using a method of cross-firing we have already approached the maximal dose obtainable for the human body. Most observers believe, however, that this is probably not altogether correct. Some significance probably must be given to the fact that higher voltage tends to ionize atoms in a different manner. The deeper penetration of the neutrons probably adds something to the depth dosage—the essential factor.

*Units and Methods of Measuring X-Rays.*—Finding a satisfactory unit for the calculation of dosage led to the common practice of stating dosage in terms of such physical factors as the kilovoltage producing the x-rays or the number of milligrams of radium employed plus time, filtration, etc. In attempting to develop a satisfactory measuring unit for radiation therapy, in the past, each worker has contended with the difficulty that equal physical measurements did not necessarily mean an equal biologic effect—the main end point of radiation therapy.

For external therapy the difficulties in establishing a satisfactory physical unit were not so great. By using the property of roentgen rays to ionize a gas and then measuring with standardized equipment the rate of ionization produced by a given source, an accurate quantitative determination of roentgen ray intensity can be obtained. After considerable work along these lines in 1928 the International Roentgen Ray Committee proposed a standardized unit of ionization measurement, i.e., the roentgen unit or r unit. The committee then defined the unit for general adoption as that quantity of roentgen radiation which, when the secondary electrons are fully utilized and the wall effect of the ionization chamber is avoided, produces in 1 c.c. of atmospheric air at 0 degrees C. and 760 mm. mercury pressure, such a degree of conductivity that one electrostatic unit of charge is measured at saturation current. In accordance with the general adoption of this r unit, the Bureau of Standards at Washington has constructed "standard ionization chambers." Universal calibration of roentgen ray equipment in terms of the r unit has resulted

in a much greater degree of accuracy; although it still remains to be determined whether or not the ionization of air is proportionate to the biologic effect for all types of radiation and for all wave lengths. This possible discrepancy, however, can be avoided for all sources of irradiation (radium or roentgen rays) by the employment of a biologic unit of measurement. An old and most practical method of such biologic standardization is the determination of the amount of radiation necessary to produce an erythema of the skin.

The dosage of radiant energy at any given depth beneath the surface can be determined by passing the radiation through a phantom of some media which has about the same density as tissue. Water, rice, wheat, etc., have been used for such experimental determinations of the depth dose.

At the present time physicists are not in agreement as to the accuracy of measuring roentgen rays and the radiation of radium by means of the same ionization chamber. The r output of radium, however, has been calculated from known physical data, and the use of 8.4 r per hour has been suggested as a standard measurement of the gamma radiation reaching a point 1 cm. distant from a source of 1 mg. of radium when filtered through 0.5 mm. of platinum. Glasser, Patterson, and Parker and others have recently suggested the use of this means of expressing radium dosage, and it will probably meet with general approval in the near future. In view of the present measurements, however, they have advised the present use of the term "equivalent r" to designate the intensity of gamma irradiation. The radiation at any given depth is measured by means of a submerged ionization chamber and compared with the same chamber's determination of the amount of energy striking the surface of the medium. The decrease is the result of the slight increase in distance and to penetration through a given depth of the medium. This depth dosage is usually expressed as a percentage of the surface irradiation in terms of the r unit (physical) or the skin erythema unit (biologic).

#### *External Irradiation by Radium*

Some men have stated that the gamma rays of radium are superior to x-rays. This is not proved, but it is possible that the gamma ray might have a greater specificity for certain tumor cells.

There are essentially two methods of applying external irradiation by the use of radium—surface application by means of a radium bomb or by means of a smaller radium pack. From 3 to 4 grams of radium are necessary for the radium bomb which is used externally. Surface irradiation, by means of a small radium pack, is used for both external and intraoral cavity irradiation. The nose or antrum is an example of the latter. Often by external surface irradiation a lethal dosage cannot be given without causing irreparable damage to the intervening normal tissue.

Small radium element or radon packs or trays may be built up for external application. For instance, at the Memorial Hospital the radon tray is built to give a dosage of about 3,000 millieurie hours. It has 2 mm. brass filtration and irradiates 24 sq. cm. and is used at a distance of 3 cm. from the skin. Such an application is used chiefly for small simple fixed recurrent

nodules of cancer. Similar large plaques can be built up for any particular situation encountered, varying the filtration, area, and focal distance according to the dosage desired.

Within the mouth, the cheek mucosa, and the palate when superficially involved with malignancy, the lesions are sometimes very efficiently treated by an intrabuccal applicator. A plaster cast may be made of the region to which the radium is to be applied. Over this (the positive cast) is beaten a piece of sheet lead 1 mm. thick. Then a second lead sheet is beaten over the first. Both lead forms are then covered with bakelite or shellac. The radium in needle form or seed form is sandwiched between the lead forms. The two

NUMBER OF MILLIGRAM OR MILLICURIE, HOURS REQUIRED  
TO DELIVER SPECIFIED DOSES TO MASSES OF VARIOUS DIAMETERS

	DIAMETER OF MASS—CENTIMETERS											
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
	NUMBER OF MILLIGRAM OR MILLICURIE HOURS											
1	26.0	65.0	104.0	195.0	260.0	312.0	377.0	442.0	520.0	702.0	910.0	1170.0
2	52.0	130.0	208.0	390.0	520.0	624.0	754.0	897.0	1040.0	1430.0	1820.0	2340.0
3	78.0	195.0	312.0	585.0	780.0	936.0	1131.0	1300.0	1560.0	2080.0	2730.0	3510.0
4	104.0	260.0	416.0	780.0	1040.0	1248.0	1560.0	1820.0	2080.0	2860.0	3640.0	4680.0
5	130.0	325.0	520.0	975.0	1300.0	1560.0	1820.0	2210.0	2600.0	3510.0	4550.0	5850.0
6	156.0	390.0	624.0	1170.0	1560.0	1820.0	2210.0	2600.0	3120.0	4160.0	5460.0	7020.0
7	182.0	455.0	728.0	1300.0	1820.0	2210.0	2600.0	3120.0	3640.0	4940.0	6370.0	8190.0
8	208.0	520.0	832.0	1560.0	2080.0	2470.0	2990.0	3510.0	4160.0	5590.0	7280.0	9360.0
9	234.0	585.0	936.0	1820.0	2340.0	2860.0	3380.0	4030.0	4680.0	6370.0	8190.0	10530.0
10	260.0	650.0	1040.0	1950.0	2600.0	3120.0	3770.0	4420.0	5200.0	7020.0	9100.0	11700.0
11	286.0	715.0	1144.0	2210.0	2860.0	3380.0	4160.0	4810.0	5720.0	7670.0	10010.0	12870.0
12	312.0	780.0	1248.0	2340.0	3120.0	3770.0	4550.0	5330.0	6240.0	8450.0	10920.0	14040.0
13	338.0	845.0	1300.0	2600.0	3380.0	4030.0	4940.0	5720.0	6760.0	9100.0	11830.0	15210.0
14	364.0	910.0	1560.0	2730.0	3640.0	4420.0	5330.0	6240.0	7280.0	9880.0	12740.0	16380.0
15	390.0	975.0	1690.0	2990.0	3900.0	4680.0	5720.0	6630.0	7800.0	10530.0	13650.0	17550.0

Chart 1.—This chart has two principal uses: (1) When 2 mg. platinum covered needles containing a known number of milligrams have been introduced into a mass whose diameter has been measured to find the minimum tissue dose which has been given in terms of skin erythema tissue dose, the top row gives the diameter of the mass and in the column below is found the number of milligram hours. On the horizontal line in the first column is given the tissue dose in terms of skin erythema dose. Example: Mass 3.5 cm. given 3,120 milligram hours has a dosage of 10 skin erythemas. (2) It may be used to find the number of milligram hours necessary to deliver a specified tissue dose to a mass of a given diameter or from within a cavity (such as the antrum) to the walls, figuring periphery to periphery as a sphere of a given diameter. For example: Diameter of cavity 5 cm. To give 8 times a skin erythema dosage, note the number of milligram hours in the intersection of the vertical column beneath 5 cm. and the horizontal column for 8 S.E.D., which equals 4,160 milligram hours.

molds are then again dipped in shellac. This denture is worn for the required number of hours daily for the required period of days to administer a dosage calculated to be lethal.

#### *Calculation of Dosage for External Radiation by Radium or Radon*

Patterson and Parker in England have recently published a very complete dosage system for external irradiation by means of tubes, needles containing radium element or radon based on the measurement of gamma radiation in

terms of the r unit employed in x-ray therapy. (Figs. 1-4.) When one considers the frequency of lesions requiring both interstitial radium and the external application of roentgen rays, some such system is necessary. In using the erythema values as equivalents in each system, one can readily compare dosages, and the actual means of calculation becomes a matter of secondary importance. One thousand r of the Patterson system equals approximately 1.1 erythema dose of the Memorial Hospital System. (Chart 1.) The dosage method of Patterson employed at the Radium Institute in Manchester is simple enough for routine clinical use and is applicable to all forms of radium therapy other than certain types of interstitial implantation. It answers two questions: How much radium is required and how must it be arranged? A value of 8.4 r per hour is accepted as the intensity of radiation at a distance of 1 cm. for 1 mg. point source of radium filtered by 0.5 mm. platinum. One

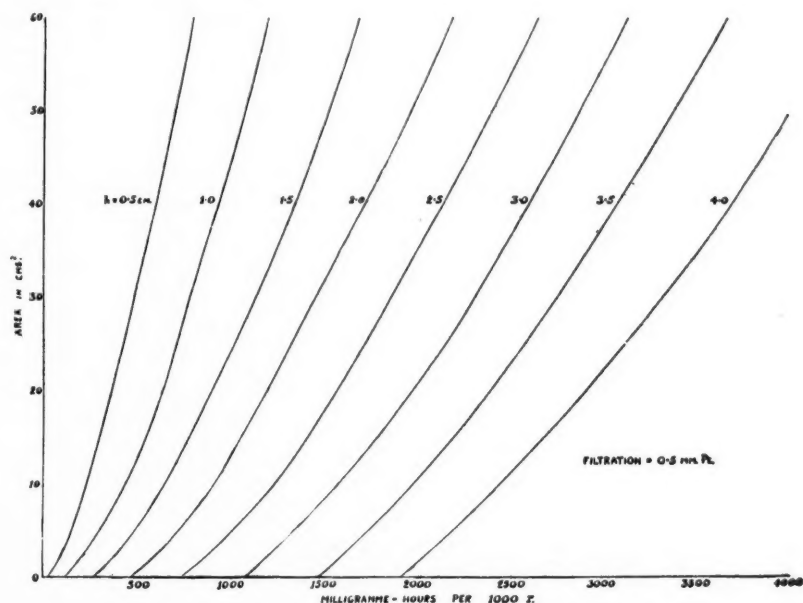


Fig. 1.—Dosage graph giving dosage up to 60 sq. cm. at distances from 0.5 to 4 cm.

thousand r was selected as the working unit, and a series of graphs constructed. The area graphs (Figs. 1 and 2) give in milligram hours the amount of radium required on flat surface applicators to give 1,000 r over any area at various distances. The tube graphs (Figs. 3 and 4) give the same data for various tubes of radium (expressed in mg. hr.) required along the central axis to give 1,000 r at the surface of the tubes. The graphs are used as follows: The dose in 1,000 r is decided upon, the graph read for area or length under consideration—to be treated—is multiplied by that number (of thousand r) which gives the number of milligram hours required. The actual amount of radium element or radon is found simply by dividing the figure by the number of hours (element) or number of millicurie hours (radon) intended. One thousand r by this unit equals about 1.1 erythema dose by the system used at the Memorial Hospital, New York (Chart 1). The problem of distribution of the foci is very important. The whole system assumes that

the distribution has been such that uniform or almost uniform irradiation is given through the area to be radiated (Fig. 6). A series of rules have been laid down by Patterson and Parker for circles, squares, rectangles, irregular

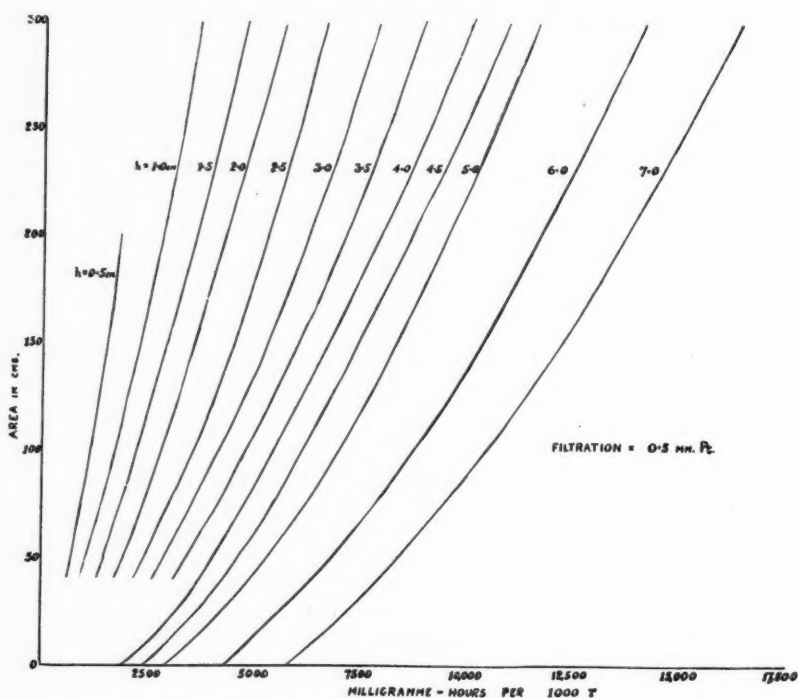


Fig. 2.—Dosage graph giving dosage for areas up to 300 sq. cm. at distances from 0.5 to 7 cm.

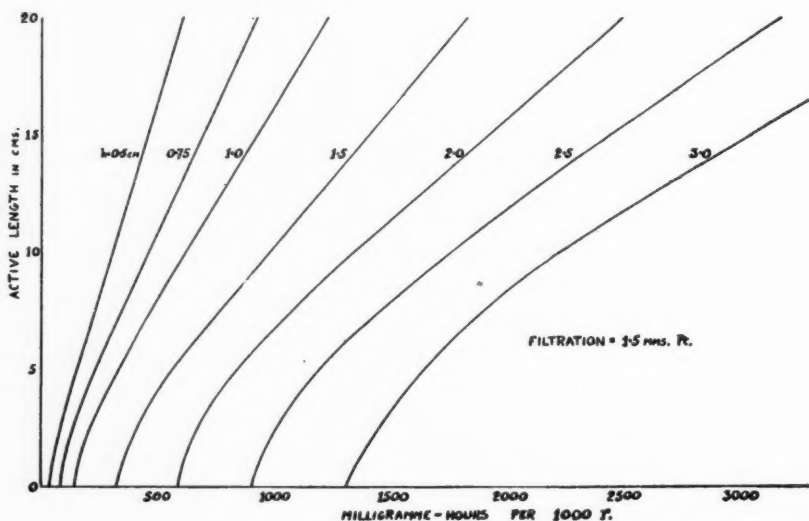
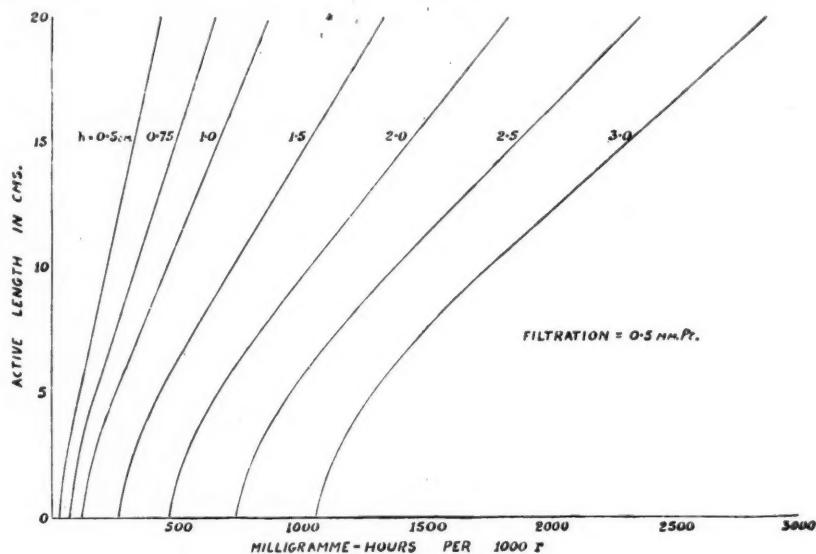


Fig. 3.—Dosage graph (for tubes 0.5 platinum filter) giving dosage at the surface of tubal applicators of lengths up to 20 cm. and for radii from 0.5 to 3 cm.

areas, convex areas, concave areas, linear or tubal applicators, and single foci.

As brief a summary as possible follows for circles. For discussion of other forms consult the article by Patterson and Parker.

1. Circles: Use circles whenever possible and arrange radium uniformly around the circumference. The minimum number of foci is six. A single circle alone is sufficient where the diameter is less than 3 times the distance ( $2.83 \times$  the diameter is ideal). When the diameter is 3 to 6 times the distance, 5 per cent of radium should be placed at the center. For larger areas use two con-



A.

Add Correction for Filter

0.8	1	1.5	2
5%	10%	20%	35%

B.

Add Correction for Rectangles

2 : 1	3 : 1	4 : 1
5%	9%	12%

C.

Fig. 4.—A, Dosage graph for tubes (1.5 platinum filter) as Fig. 3 but for heavier filtration. For filtration 1 mm. of platinum the mean of the readings from Figs. 3 and 4 should be taken.

B, The area graphs Figs. 1 and 2 are for 0.5 mm. platinum. If other filtrations are used, the above corrections are necessary. Gold equals platinum. Lead and silver as half their thickness of platinum. Monel, brass, etc., as one-third their thickness in platinum.

C, The charts apply strictly for circles and for squares. For rectangles proceed as for squares, adding the additional lines parallel to the longer side and make correction in the direction of increased milligram hours as above.

Graphs and corrections in Figs. 1-4 are after Patterson and Parker.

centric circles and a center spot as follows: 3 per cent of radium at the center. For the outer circle use percentage of radium as used in this table:

Diameter divided by distance	6	$7\frac{1}{2}$	10
Per cent radium outer circle	80%	75%	70%

For the inner circle distribute the remainder around a circle or half diameter. For circles at small distances the last arrangement is not practical. The following is substituted:

Diameter 6 - 7 $\times$ distance	= 10 per cent radium at center
Diameter 7 - 9 $\times$ distance	= 20 per cent total radium at center

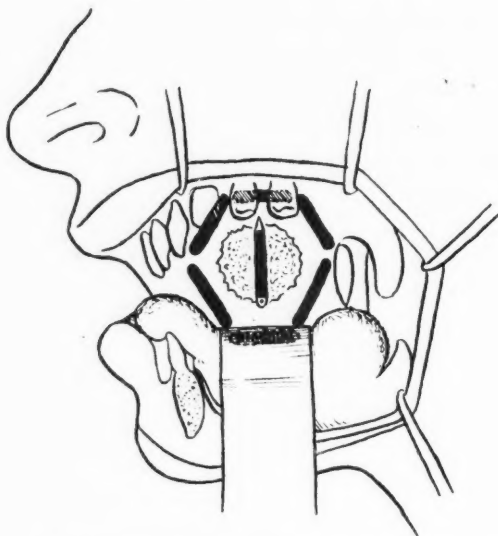


Fig. 5.—Example: Epithelioma of the mucosa of the cheek. Size of lesion 3.5 cm. in diameter. Treatment 0.5 cm. mold. To give 10,000 r in twenty days (mold applied sixteen hours per day).

Calculation:

Treat area 5 cm. diameter = 19.5 sq. cm.  
Mold distance = 0.5 cm.  
1,000 r at 0.5 cm. = 400 mg. hr.  
10,000 r = 4000 mg. hr.

No correction for filtration 0.5 mm. platinum

Distribution:

Diameter  $5 \times$  distance  
Therefore single circle plus 5 per cent center spot.  
Use 6-2 mg. tubes in a circle plus 1 mg. tube as center spot.  
Dose at 1 cm. below mucosa  
At new distance of 1.5 cm.

1000 r = 630 mg. hr. actually used = depth dose =  $\frac{4000 \times 1000}{630} \text{ r} = 6349 \text{ r}$ .

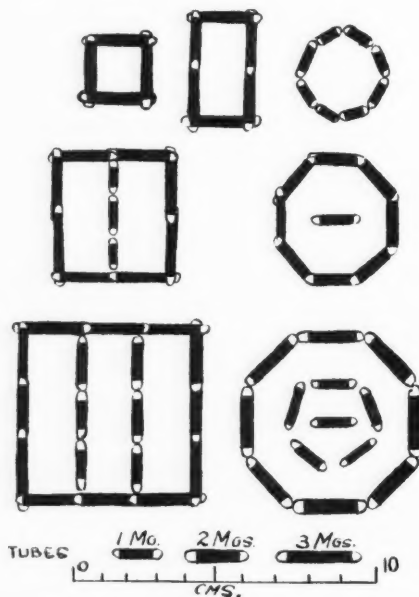


Fig. 6.—Diagram illustrating the rules for distribution depicting typical arrangement to produce homogeneity at 1 cm. distance (after Patterson and Parker). See their article for diagram of how the system can be adapted to whatever types of radium containers are available.

Frequently it is possible, as on the lip, cheek, and alveolus, to sandwich a growth between two molds in such a way that a fairly homogeneous dosage is given through and through the tissue. To do this the applicator is prepared with two molds paralleled with each other (Fig. 7). To calculate, figure dosage at successive distances from applicator *A* which will progressively decrease as the distance decreases. Then calculate dosage at successive distances from applicator *B* which also will progressively decrease as the distance decreases but in the opposite direction. Then add *A* and *B* calculation together as shown in Fig. 7 for total dosage at any given point. This dosage system provides accurate measure of actual radiation.

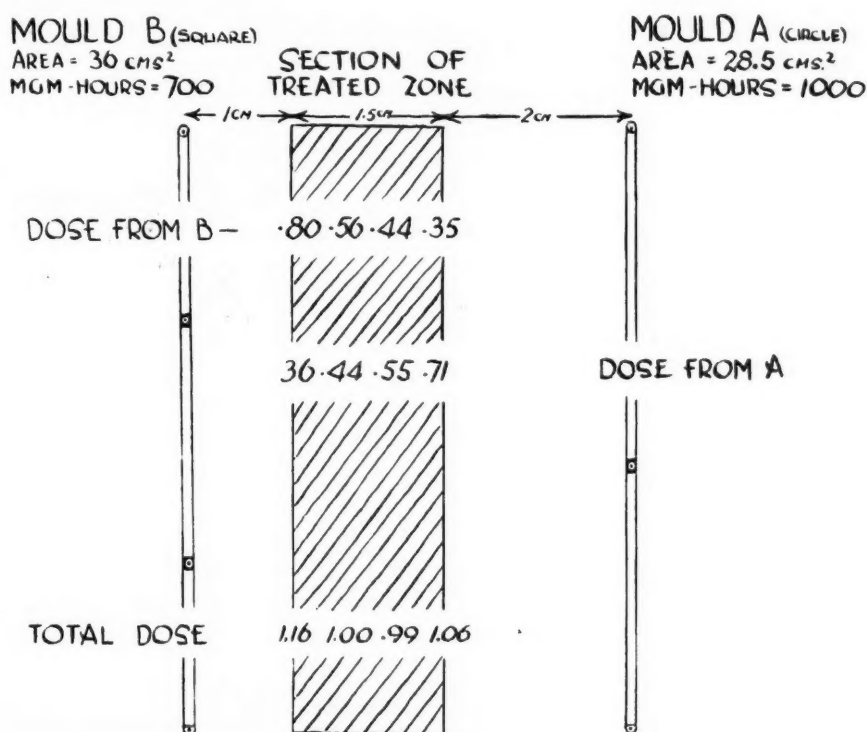


Fig. 7.—To calculate, figure dosage at successive distances from applicator *A* which progressively decreases as the distance decreases (latter part of legend for Fig. 5 gives example of figuring dosage at a given depth). Then calculate dosage at successive distances from applicator *B* which also will progressively decrease as the distance decreases but in the opposite direction. Then add *A* and *B* together as shown for total dosage at a given point (after Patterson and Parker).

Experience has taught not only that the actual dosage is important but that the period of time over which the dosage is given is also of vast importance. As the length of time increases, the size of the dose required to produce reaction on tissue increases. In the transference of actual dosage to a biologic reaction of a given intensity the standard set for the following results was irradiation continuous or nearly continuous over a period of eight days. For normal skin 3,000 r gave a faint erythema, 4,500 r a definite erythema, 6,000 r moist desquamation, 7,500 r more marked to borderline of safety; 9,000 r resulted in a certain percentage of radium necrosis. For buccal mucosa a dosage of as high as 12,000 r can usually be tolerated with eventual return to normal.

For squamous cell epithelioma 6,000 r delivered to all parts of the tumor—not at surface—usually caused regression and may be taken as tumor lethal dose. For permanent response of basal cell epithelioma about 5,000 r was considered necessary.

#### INTERSTITIAL IRRADIATION

In the second method, interstitial irradiation, the radiant energy is applied in the form either of needles or of permanent buried radon implants (Fig. 8). The needles are sewed in situ and removed after a given period of time. Radon seeds may or may not be buried permanently. Their use undoubtedly represents one of the most efficient and practical ways of applying interstitial radiation. In a considerable number of great clinics, however, needles containing radium element are used by preference (the Curie Institute

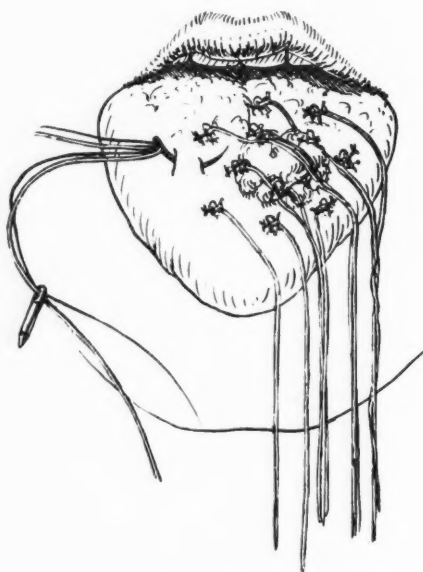


Fig. 8.—Diagram of method of inserting needles interstitially in malignant lesion of the tongue. The dosage would be calculated from Chart 1.

and Radiumhemmet, etc.). These clinics do this on the basis that a continuous equal source of radiation over a period of time gives better results than radon which has a half life period of a little more than three days.

In the practical use of needles or seeds, certain advantages and disadvantages arise. One disadvantage in using needles is the necessity, as a rule, of hospitalizing the patient, which is not always the case after radon seeds are implanted. Needles are somewhat more cumbersome. They have to be sewed in. Their puncture holes make avenues for infection. In some situations such as the oral cavity, the hypopharynx, and certain anatomic tubes, it is practically impossible to implant needles containing radium element from the inside. In such regions radon seeds may have some advantage in applicability, although often some "surgery of access" through an external incision is likely to be the most efficient way of gaining accurate implantation. Theoretically, interstitial radiation is fraught with a slight danger of disseminating car-

cinoma cells. Again, when a slight error is obtained in the distribution of the foci, certain carcinomatous cells may survive and a recurrence eventually occurs. This is one reason for postponing glandular removal until after the local lesion is eradicated.

When using interstitial radiation a mere knowledge of the amount of radium, filtration, time, etc., is not sufficient. One must consider the relative effect of radiation at varying distances from its source. It then becomes necessary also to know the size and shape of the lesion in order to plan the distribution of radiant sources so that a lethal quantity of energy may be delivered throughout the tumor-bearing area. With correct introduction and espacement of radioactive foci a lethal dose can be given to even fairly radio-resistant neoplasms, provided the tumor is not so large that the quantity of radiant energy necessary is incompatible with the life of the individual.

*Interstitial and Inter Cavity Measurement.*—When using interstitial irradiation the problem of obtaining a satisfactory unit of dosage is much more complicated. No iontoquantimeter has been constructed which allows one to calculate accurately dosage in terms of physical units throughout an area containing a group of interstitial implants of radium or radon. Within the past few years, the group of workers in the biophysics department at Memorial Hospital (New York) have done some of the experimental work necessary to establish a method of interstitial dosage estimation accurate enough for practical purposes. Their methods of indirect experimentation took advantage of the properties of radiation to bleach butter, to cause tissue necrosis in rabbits, and to produce an erythema of the skin in the human being. As the bleaching effect of radium upon butter is proportionate under certain conditions to the production of tissue necrosis or to the formation of skin erythema, an experimental comparison was made so that a biologic unit dosage table of some accuracy for interstitial irradiation in various shaped masses could be constructed. They selected as the most satisfactory unit of skin erythema a "threshold erythema dose" and defined it as "that amount of radiation which in 80 per cent of all cases after a single application will produce a faint bronzing or reddening of the skin in about three weeks and in the other 20 per cent will produce no visible effect." No single unit of radiation has been found to be entirely satisfactory, but this one is possibly as satisfactory as any yet proposed. By means of comparative distribution curves reduced to terms of skin erythema dose, one may calculate the percentage of radiation delivered to any point within a given distance from the implant.

In suggesting a practical application of their studies, Martin and Quimby have advocated that each mass to be radiated by interstitial methods be carefully measured and considered as a sphere or as two more adjacent or overlapping spheres. After placing needles or radon seeds in a given tumor, each implant could then be considered as a point source, and the focus of any given intensity or dosage about one implant would then constitute a hypothetical sphere with the implant at its center. They point out that two or three implants cannot logically be placed so as uniformly to irradiate a sphere, since the sources would not lie in a single plane. In this connection they pointed



platinum the variation in dosage due to change of filtration is not very marked. The chart can be used without correction. Somewhat recently Quimby and Stewart discussed the "comparison of various sources of interstitial radiation." Space forbids a résumé of the influence of this factor.<sup>16-18</sup>

#### EXTERNAL PLUS INTERSTITIAL IRRADIATION

The third category—external plus interstitial radiation—represents the most generally useful method of application of a lethal tissue dosage of radiation. To obtain the necessary lethal dose to a radioresistant lesion, the two methods are used as adjuvant sources of radiant energy. Pertinent to combining radium and roentgen radiation is the work of Quimby and Pack, who showed that the production of a skin erythema by a half-and-half combination of gamma (radium) and roentgen rays requires a total of 30 per cent more radiant energy than when either is used alone. It is possible that this work cannot be applied to cancer therapy, since the cancer cells as well as the skin may tolerate the increased quantity of combined irradiation. It is the impression, however, of several groups of workers that there is a distinct clinical advantage in combining roentgen and radium therapy.

In the use of irradiation the question of the effect on tissue of radium or roentgen rays alone or in combination is of some interest. Ewing has been of the opinion that the gamma rays of radium act chiefly by direct action on the cells and that roentgen rays act chiefly by causing changes in the tissue bed about the cancer cells and further, in the case of roentgen rays, that the reaction in tissue appears later than that produced on tumor cells by gamma rays. Although lacking confirmation, it has been stated that the roentgen ray therapy should precede the gamma therapy when both are used.

TABLE I

Voltage	150 KVP	200 KVP	250 KVP	300 KVP
SKIN TARGET DISTANCE = 80 CM.				
Filter	Copper 0.25 mm.	Copper 0.50 mm.	Copper 2 mm.	Copper 3 mm.
Intensity on the surface	100.0%	100.0%	100.0%	100.0%
Intensity at a depth of				
2.5 cm.	87.5%	88.0%	90.0%	88.0%
at 5.0 cm.	66.3%	70.0%	73.9%	70.6%
at 7.5 cm.	56.3%	59.5%	62.1%	62.5%
at 10.0 cm.	41.6%	47.4%	50.4%	51.8%
at 12.5 cm.	33.3%	36.8%	39.3%	41.2%
at 15.0 cm.	25.8%	30.0%	32.2%	33.1%

Besides showing the depth dosage on a percentage basis taking the surface as 100 per cent, Table I shows the gain in the "percentage depth dose" when heavier filters are employed at higher voltages. Our machine at present is used at 300 KVP. The increase in percentage of depth dosage is compared with other voltages.

In determining the amount of x-ray given, the percentage erythema dose on the skin given at each treatment is tabulated, and then the proper depth dosage curve (Fig. 9 and Table I) and the percentage of surface radiation delivered at the tumor depth for each treatment are calculated. The latter percentage is multiplied by the former percentage, which gives the tissue dose for each treatment. The total tissue doses given at all treatments are added.

If a radium pack were used in conjunction, the percentage depth dose would be added to the x-ray percentage depth dose.

The method of calculating the tissue dosage when radium or radon is used interstitially in terms of skin erythemas has previously been given (Chart 1). As an example of interstitial radiation plus external radiation one might prescribe to a given tumor 7 skin erythema doses by means of interstitial radiation, and 3 skin erythema doses by means of external irradiation by x-rays. Thereby the total tissue dosage of irradiation becomes 10 S.E.D.

A summary of the steps in calculation of the total radiation necessary to give a specified tissue dose when using interstitial radiation in combination with external radiation follows.

(1) Specify the tissue dose, (2) decide amount advisable, (3) determine distance from the depth of the lesion to each portal on the skin for external radiation. From the proper curve (either x-rays or external radiation) for depth dosage determine the percentage of the surface radiation delivered at the given depth for each treatment. Multiply this percentage for each treatment by the calculated percentage erythema dose on the skin. This gives the tissue dose for each treatment. (4) Subtract the tissue dose obtained from the superficial dose (1), the remainder is to be given by interstitial radiation. (5) Determine the three dimensions of the lesion. (6) Decide what sphere or group of spheres to consider as defining it. (7) For a single sphere the larger diameter of the mass is taken and from Chart 1 the number of milligram or millicuries necessary to give the dose specified in (4) is determined. (8) For a group of spheres the number of milligram hours or millicurie hours necessary to give the dose specified in (4) from data found in column for the diameter of one sphere of the group, multiply this by the number of spheres. This gives the dose of interstitial irradiation required. (Lee, Pack, Quimby and Stewart.)

#### IRRADIATION PLUS SURGICAL INTERVENTION

The fourth category—radiation (external and interstitial) plus surgical intervention—represents still another combination of weapons that in certain relatively radioresistant tumors affords a more certain method of destruction. For instance, a radioresistant tumor in an anatomic location in which surgical excision is feasible may sometimes best be excised as an additional precaution against the persistence of a viable tumor focus after thorough irradiation. Berven has obtained 15 three-year cures out of 20 cases of cancer of the tongue by this method. Although the series is small, results the equal of these have not been reported previously. Again, in a large somewhat radioresistant tumor, a lethal dose of irradiation may require a dosage too great for the patient to withstand. In such a situation it may be wise to radiate the tumor by external methods and then excise it, after which interstitial radiation may be employed at suspicious points.

#### THE BASIS OF SURGICAL EXCISION

After the rather lengthy résumé of certain conceptions concerning irradiation therapy, it may be assumed that surgery has little place in the treatment of cancer in and about the oral cavity. This is not at all the case. In many types of cancer, surgery is still the bulwark against which one rests when a cure is contemplated.

In the beginning, cancer is supposed to be a local lesion; and, presuming that this is the fact, surgery should be effective if the local lesion is removed. To be on the safe side, an additional margin of normal tissue also should be

removed; and, when the life history of the tumor indicates that metastasis is likely to occur to the lymph tributary nodes, they should be removed as an additional precaution.

It makes no difference what type of instrument is used for the surgery, whether a knife, the endothermic knife, or cautery, as far as the principle is concerned. The object is complete removal of all tissue that might be involved with cancer. Generally speaking, whenever complete removal is not possible, the situation should be regarded as being beyond help from surgery.

Finally, in conclusion it may be stated with truth that the outlook of the cancer patient has improved vastly in the past few years. Advances have been made largely due to the combined efforts of the surgeon, the radiologist, and the pathologist working together and concentrating on the subject of cancer as it occurs in the human being.

The matter of the regional application of radium and the surgical treatment will be discussed subsequently.

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## CONSIDERATION OF ABNORMALITIES, DEFORMITIES, AND PATHOLOGIC CONDITIONS OF EDENTULOUS MOUTHS

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THE abnormal and pathologic conditions of edentulous mouths are many. They may not differ fundamentally from those of dentulous mouths, but when the discussion centers around the edentulous mouth it naturally leads to a consideration of the proper retention and the proper functioning of artificial dentures. Therefore, this paper will present only such pathologic and abnormal conditions as have a direct influence on the efficiency of prosthetic appliances.

Perhaps as a starting point it may be desirable to have in mind the tissue changes that follow the extraction of teeth under normal conditions and then discuss the various pathologic and traumatic factors that modify or delay the healing process or leave their final mark on the tissues of the mouth and the contour of the alveolar ridges.

When healthy teeth are removed from the alveolar socket without undue trauma to the bony as well as the soft tissues, the socket is immediately filled with blood which soon coagulates, becomes organized fibrous tissue, and ossifies. In the meantime the sharp edges of the bone along the margins absorb, and the entire raw area surrounding the crest of the alveolar ridge is covered with hard, dense, fibrous, connective tissue. The greatest change in the mouth tissues after the removal of teeth is in the alveolar ridges. Palate, buccal and lingual folds suffer comparatively little unless badly traumatized.

An ideal edentulous mouth consists of well-rounded, moderately high alveolar ridges covered with dense but resilient fibrous tissue well supported by bony structure. The contour and the nature of the tissues of the alveolar ridge are the most important for good retention of the denture, as they are the stress-bearing area for mastication. The palatal vault of the normal maxilla should be moderately high and rounded. The soft tissues of the palate differ in their density and histologic structure; the anterior part immediately behind the ridge is covered with hard, irregular, resilient fibrous tissue called rugae palatinae; while, at the lateral aspect, the tissues are more resilient, containing a moderate amount of fat, mucous glands, palatal nerves and vessels. The condition of the palatal vault is also important from the point of view of retention of maxillary denture. The central part where the two halves of the maxillary bones join is covered with firm, thin, fibrous tissue. An important area to remember in the relation of the maxilla is the outline of the periphery of the alveolar ridge. This outline is quite irregular and is influenced by the presence of fibrous bands and attachments of the various muscles of expression and mastication. The higher

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the buccal fold and residual ridge, the greater the usefulness of the alveolar ridge for the retention of a denture.

An ideal mandible should have primarily a well-rounded, moderately high alveolar ridge covered with dense but resilient fibrous tissue. The buccal sulcus should be broad and free from fibrous and muscle attachments over the crest of the ridge. The greater the resting area, the more stable the denture, provided everything else is equal. In addition to the qualifications given above, an ideal edentulous mouth should have good intermaxillary space and a proper relation of the maxillary and mandibular alveolar ridges. One might add that in younger patients the vitality of the tissues is greater, and this seems to reflect also upon the retention of the denture.

This is perhaps a fair statement of what a normal mouth should be. There are many factors, however, that may modify this normal process and may make the mouth tissues less favorable for the construction of satisfactory dentures. To begin with, healthy teeth are seldom, if ever, sacrificed for replacement by artificial dentures. There are, however, many pathologic processes through which the teeth and jaw tissues undergo changes that influence the future state of the alveolar ridges. The following are some of the most important:

#### PATHOLOGIC LESIONS INFLUENCING THE JAWS

1. *Pyorrhea alveolaris* is the cause of the loss of many teeth, and as its destructive action also involves the loss of alveolar bone, we cannot expect ideally well-rounded and prominent alveolar ridges when the disease has already done its destructive work. Under these circumstances the alveolar ridges are bound to be flat with a shallow buccal fold and covered with flabby soft tissue.

2. Badly decayed teeth combined with degeneration of the pulp, periapical infection, granulomas and cysts, affect the vitality of the alveolar bone making the extraction of the teeth more difficult, subject the traumatized tissues to infection and lead to stormy convalescence and eventual change in the contour of the areas most needed for the stabilization of the dentures.

3. Major pathologic conditions such as osteomyelitis and malignant tumors often lead to gross deformities of the jaws and completely alter the normal outline of the mandibular and maxillary bones. They may destroy enough of the soft tissues of the mouth to cause partial ankylosis, cicatricial contraction, perforation of the palate, etc.

4. Acute ulcerative lesions from undue pressure upon an isolated area of the mouth. The treatment, of course, lies in removing the cause, which may be undue pressure of the borders of the denture, a rough, unfinished area, or faulty articulation of the teeth.

5. Diffuse chronic inflammation of the mouth tissues limited to the area covered by the dentures. This was recognized by dentists in the past and given the name of "rubber sore mouth." In this respect one often finds the mucous membrane under the denture bright red, slightly edematous and tender, and the margins limited to the resting area of the denture. This pathologic condition, at present quite rare, seemed to appear soon after the discovery of vulcanite rubber as a base for artificial dentures and was investigated by earlier writers. At first, it was thought that the inflammation was due to mercuric

action arising from some clinical change in the vermilion used in coloring the rubber. The most plausible explanation was advanced by Black who demonstrated that on account of the porosity and comparative roughness of the surface of the rubber, certain fungi grew rapidly and were elaborated in acid secretions and acted as an irritant to the mucous membrane. There is no doubt that in patients suffering from this condition one often finds absolute neglect of the proper care of the denture. They allow food particles, mouth secretions, including salivary deposits, to gather over the appliance. Therefore, it is of great importance to emphasize cleanliness. If the patient is suffering from a debilitating disease such as diabetes, pernicious anemia, or leucemia, the mucous membrane of the mouth will be more sensitive than that of a normal person and the patient should be more scrupulous about the hygiene of the mouth and cleanliness of the denture.

#### TRAUMATIC CONDITIONS INFLUENCING THE JAWS

Trauma in its various forms has great influence on the eventual contour of the ridges. Accidents involving fractures of the jaw and alveolar processes and laceration of the soft tissues often create difficult problems. The main contour of the jaws and their relative position may be entirely distorted through the loss of tissue or existence of adhesions of the mobile tissues over the crest and alveolar ridge. Injuries caused by operations for the removal of teeth are more common than those resulting from accidents. I am well aware that the extraction of teeth frequently presents many difficult situations. Roots, especially those of devitalized teeth, surrounded by dense bone cannot be dislodged without sacrificing part of the alveolar plates. The fact remains, however, that any loss of alveolar bone is bound to affect the normal healing process of the socket and leave its mark on the eventual contour of the ridge. Likewise, laceration or indiscriminate sacrifice of the delicate gum tissue will result in the distortion of the peripheral boundaries of the ridge and cause various degrees of adhesions which are often difficult to repair.

Ill-conceived and poorly executed alveolectomy operations have in the past caused many failures by the sacrifice of too much bony tissue. Fortunately, more discriminate use of this surgical procedure prevails today, and it is largely limited now to abnormal cases.

Among traumatic cases we must also include the effect of ill-fitting dentures on the mouth tissues. Here we have a whole series of abnormal and mildly pathologic conditions which require serious attention. Excessive absorption of the bony alveolar ridge is frequently found in the anterior part of the maxilla and almost the entire mandible. We are all familiar with the effect of the heavy metal mandibular dentures which were constructed a few years ago. These abnormally heavy dentures were made for the purpose of gaining more stability. An examination of the mouths of patients wearing these dentures invariably showed great absorption of the mandibular bone. Fortunately, the improved technic of denture construction has superseded the use of such plates. However, even with the use of lighter dentures, excessive absorption of bone is inevitable if the masticating stress of the denture is not evenly distributed over the entire crest of the alveolar ridge. This is exemplified in patients who have

been wearing dentures made on plane line articulators with the anterior teeth having an edge-to-edge bite. These patients in order to masticate food are obliged to use the up-and-down motion instead of the normal lateral motion. As a result there is abnormal stress on the anterior alveolar ridges and eventual absorption of bone in that region and its replacement with soft flabby tissue which has no stress-bearing power.

The wearing of ill-fitting dentures over a long period of time may cause many abnormalities and pathologic conditions of a truly traumatic type. No reflection on the accuracy of dentures when first constructed is herein implied. But how often we find patients who fail to appreciate that mouth conditions change from year to year and that dentures should be frequently inspected and perhaps adjusted. As a result, many patients wear for many years dentures constructed as only temporary appliances.

Under such circumstances, normal absorption of the alveolar bone occurs, and the resulting space is filled with hyperplastic mucous membrane. At other times, the constant irritation of the borders of the dentures appears to stimulate, along the periphery, the formation of tissue resembling small fibrous tumors. Generally, when the cause of the irritation is removed, the tissues are likely to resume their normal state; yet occasionally we find extensive growths of fibrous tissue which can only be treated surgically.

#### DEVELOPMENTAL ABNORMALITIES

There are a number of abnormalities which, while they may not be considered pathologic or traumatic as long as the patient still possesses his natural teeth, create mechanical difficulties for the construction of dentures after the teeth are removed. They may be called developmental abnormalities and may be listed as follows:

Overprominent alveolar ridges, exostosis, hypertrophy or atrophy of the soft tissues over the alveolar processes and palate.

The presence of prominent alveolar ridges may not handicap efforts to secure retention of a denture, yet they often reduce the intermaxillary space and cause abnormal bulging, thus creating difficulties in setting the teeth, with a corresponding sacrifice of esthetics.

Among the many bony prominences, called exostosis, torus palatinus in the median raphe of the palate is most common. Bony projections at the lingual aspect of the mandible and abnormal prominence of the tuberosity of the hard palate are not infrequent. None of these conditions is pathologic. The patient is rarely conscious of them, and even a large torus palatinus overhanging the center of the palate seldom causes the patient to complain; but when circumstances oblige a patient to use artificial dentures, the presence of such conditions will occasion distinct mechanical difficulties.

The scope of operative treatment in edentulous mouths covers a wide field, and the object is, first, to improve the contour of the alveolar ridges for the retention of dentures and, second, to remove pathologic lesions. In the latter case one is often obliged to sacrifice considerable tissue of the jaws in order to eradicate the disease. This part of the operative treatment will not be discussed here, as that should be considered from another angle.

My object in this paper is to outline the operations and conditions which I discussed in the first part of my paper.

The treatment of acute lesions caused by irritation from a denture consists of the removal of the cause of such irritation. Even localized fibrosis along the periphery of the maxillary ridge will often disappear as soon as the ill-fitting denture has been discarded. However, lesions that caused permanent changes in the contour of the bony and soft tissues of the jaws, as well as jaws with abnormally prominent alveolar ridges, require surgical interference.

Before going into a detailed description of some of the important surgical procedures, I should like to emphasize once more the importance of avoiding unnecessary trauma in operations for the removal of teeth. With the modern improvements in the administration of local and general anesthesia, the operator is not forced to resort to a speedy performance of his work.

#### ALVEOLECTOMY

A great deal has been written recently regarding alveolectomy immediately following the extraction of teeth. Normal, well-proportioned jaws do not require any more manipulation of the bony and soft tissues than the slight trimming of the sharp bony edges and the suturing of the lacerated tissues. It sometimes becomes necessary to trim the alveolar ridges in order to establish normal proportions for esthetic as well as mechanical reasons. In such cases, the mouth should be studied carefully on articulated models to determine just how much tissue must be removed. Thus, alveolectomy becomes a desirable procedure for the care of abnormally prominent alveolar ridges.

Many minor defects characterized by bony projections, such as exostosis and torus palatinus, are easily repaired by an incision over the area and retraction of the soft tissues until the prominence is well exposed. Its removal may be accomplished with rongeurs or chisels. The surface is then smoothed, and the wound closed with silk or any similar sutures. Occasionally it may be necessary to remove a part of the soft tissues where there is an overabundance.

In a previous paper<sup>1</sup> I have outlined various operative procedures for the correction of certain abnormalities of the mouth. In this paper I shall call your attention again to two operative procedures for reconstruction of the alveolar ridges.

The first procedure is particularly for cases characterized with excessive absorption of alveolar bone and the subsequent loss or diminution of the gingivolabial fold. This condition is more common with the mandibular ridge where often the mandibular denture has hardly any solid base to rest upon. The main purpose of the operative procedure is to extend the periphery of the mobile tissues further back buccally or lingually if necessary so as to give the denture more resting area over the alveolar ridge.

The general outline of operative procedure consists of making (1) a pedicled flap of mucous membrane of the buccal alveolar process extending toward the cheek. The base of this flap extends along the crest of the ridge through which it receives its blood supply. This flap should be at least one-half inch long and should extend along the entire side of the ridge or only half of it. (2) The buccal periosteum is exposed and freed of all fibrous and muscular attachments

as far back toward the periphery as is necessary. (3) The mucous membrane flap is sutured to the periosteum while the outer margin of the incision band along the lower border of the cheek or the lip is fastened to the bone of the ready-made groove either by suturing it to the periosteum or, still better, by using through-and-through sutures through the skin. (Figs. 1 and 2.)

There are one or two points of technic that must be followed for successful results. First, the incision line should be far enough from the ridge to allow enough mucous membrane to cover the newly formed ridges; second, the periosteum must not be disturbed, but all the submucous tissues, including the attachments of the muscles of expression, should be pushed apart from it; and care must also be taken in suturing not to tear the periosteum. This operation is equally adaptable for re-formation of the buccal groove for either the maxilla or the mandible.



Fig. 1.

Figs. 1 and 2.—A horizontal incision is made on the inner side of the lip, or cheek, 1.5 cm. from the center of the ridge. With a sharp knife the mucous membrane is undermined toward the center of the alveolar ridge. The loose fibrous tissues over the periosteum and under this mucous membrane flap are removed until sufficient periosteum is exposed to be covered by the mucous membrane flap. The raw surface of the lip is then covered by bringing down the incised edge of mucous membrane to the depth of the newly made groove, and held there by mattress sutures passed through the skin. Similar procedure may be used on the lingual side of alveolar ridge. In this instance, both the incision edges are held in their new position by sutures through the periosteum.

The second operative procedure is for the removal of protrusion of the alveolar processes. In this operation it is necessary to remove a considerable amount of alveolar bone. This may often result in a reduced buccal groove. The following procedure will restore adequate gingivolabial fold and proper height of the residual ridge in addition to the reduction of the protrusion of the alveolar ridge. The principle of the operation consists of exposing the alveolar process first, by making an incision over the center of the ridge and trimming the necessary amount of bone; second, by separating the mucoperiosteum from

the buccal alveolar plate as high as possible and raising the entire buccal flap in a higher position and holding it there until healing is complete.

The peripheral boundaries of artificial dentures are influenced by the attachments of various muscles of expression and certain fibrous bands which mark the beginning of mobile and active tissues.

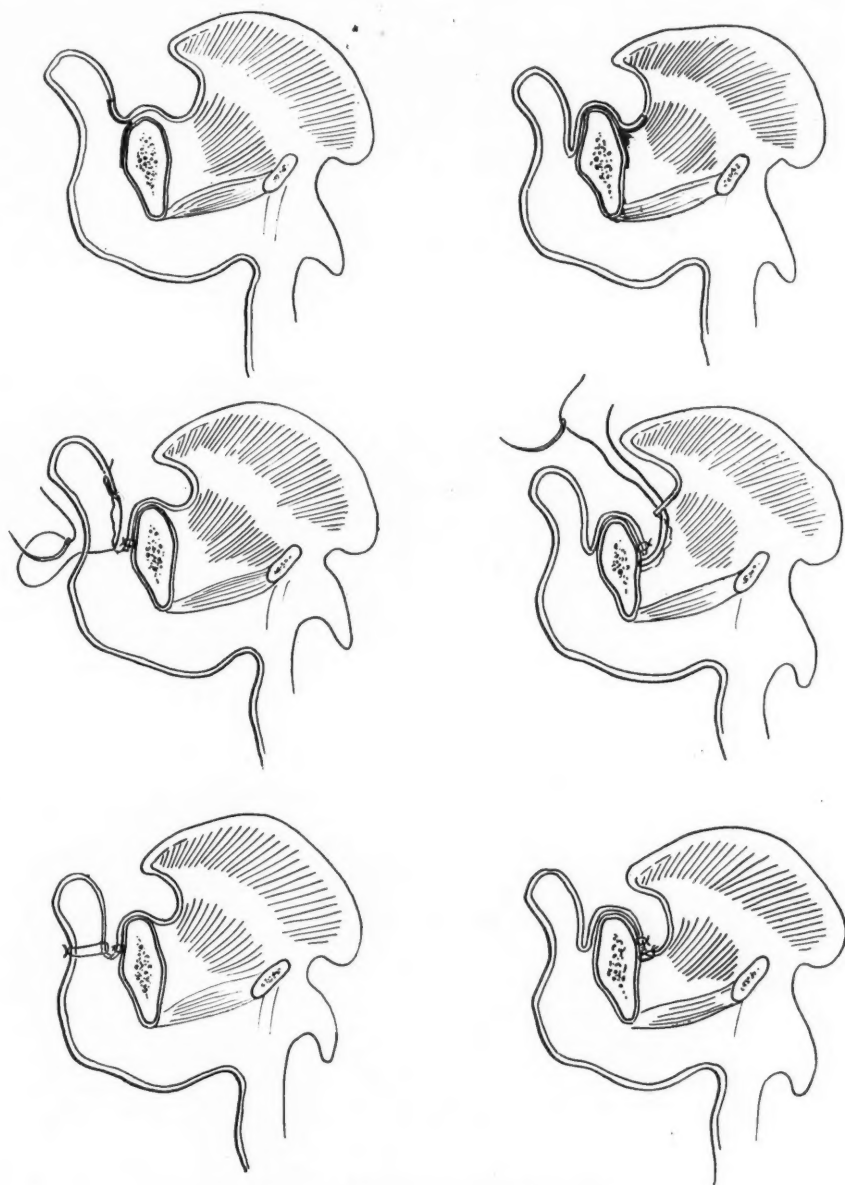


Fig. 2.—(See legend on opposite page.)

This operative procedure is intended simply to transfer the attachments of muscle fibers into different positions.

An incision is made along the prominent margin down to the bone (Fig. 3A). All tissues are carefully elevated, not only to the palatal surface but also anteriorly, well up to the anterior nasal spine and canine fossa. Extensive

undermining of the tissues is important. (Fig. 3*B*.) Excessive bone is removed by a rongeur (Fig. 3*C*); the labial flap is carried high up, and the margins of the incision are approximated by interrupted sutures. The removal of bone allows the labial flap to slide to a higher position which is maintained by

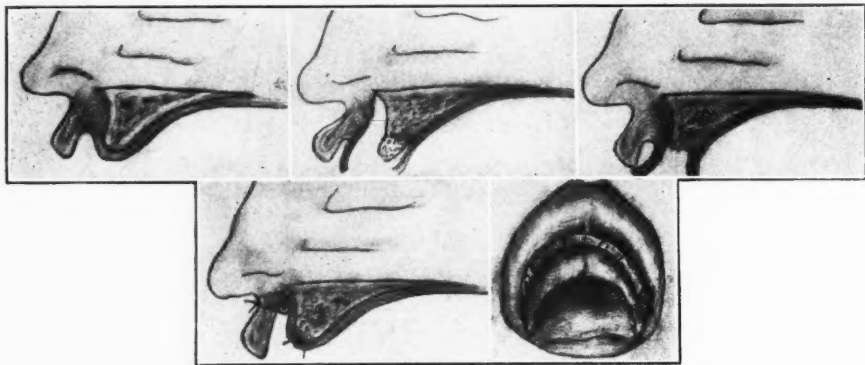


Fig. 3.—Various steps of operation for removal of prominent alveolar ridges without sacrificing the height of the gingivobuccal fold.

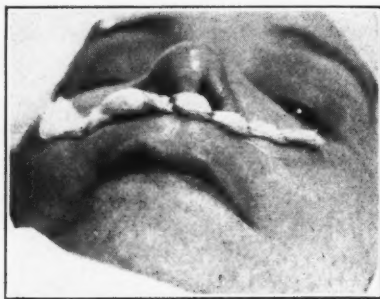


Fig. 4.—Interrupted mattress sutures tied over gauze to prevent the cutting of skin.



Fig. 5.—Elastic band fastened under tension with adhesive tape over the lip dressing to maintain pressure from without and to control edema.

placing a small flexible rubber tube well up under the lip and passing interrupted mattress sutures around it and through the lip onto the face as shown in Fig. 3 *D* and *E*. These are so placed as to create an upward tension on the mucous membrane surface. They are tied over gauze to prevent the cutting of

the skin (Fig. 4). A dressing is then placed over the lip and strapped in place with adhesive. This adhesive strap is split, and one-half is placed over the nose for support (Fig. 5). To help control edema and to maintain pressure externally,



Fig. 6.—Position of rubber tube high up along gingivobuccal fold.

Fig. 7.

Fig. 10.



Fig. 8.

Fig. 9.

Fig. 7.—Preoperative photograph of patient (Case 1). Note the fullness of upper lip.

Fig. 8.—Model showing occlusion of teeth prior to extraction of maxillary teeth. (Case 1.)

Fig. 9.—Photograph of model of maxilla following extraction of teeth and extension of ridge. Note the height of ridge at the anterior region. (Case 1.)

Fig. 10.—Postoperative photograph of patient (Case 1) wearing artificial maxillary denture.

a double elastic band may be fastened under tension with adhesive over the lip dressing. The band can be removed the next morning, but the sutures and the rubber tube should not be removed for four or five days.

The tension of the rubber tubing maintains adequate and equalized pressure on all the tissues and ensures a good gingivolabial fold, which will not close when the sutures and the tubing are removed. (Fig. 6.)

In operations on the anterior part of the maxilla, it is often necessary to remove a section of the anterior nasal spine in order to allow a higher buccal sulcus.

Fig. 11.

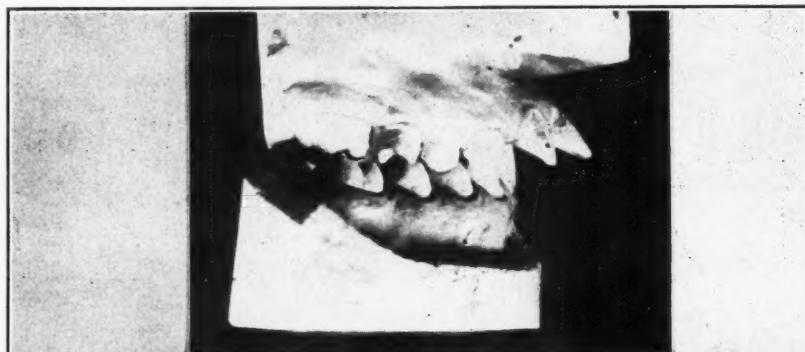


Fig. 12.

Fig. 13.

Fig. 11.—Case 2, marked overbite of anterior maxillary teeth.

Fig. 12.—Case 2, maxillary incisors inclined forward at about a 45 degree angle.

Fig. 13.—Case 2, after operation and insertion of maxillary artificial denture.

#### CASE REPORTS

CASE 1.—Patient J. H. H. was advised by his dentist to have all his maxillary teeth removed and was referred to the Harvard University Dental School on November 16, 1934. (Fig. 7.)

Examination of the mouth as seen from the photograph of the teeth (Fig. 8) showed a considerable open-bite and protrusion of the maxillary anterior teeth. A study of the models as well as the general facial outline convinced us that it was necessary to do a certain amount of alveolar resection after removing the teeth. The operation was performed under local anesthesia and followed the general plan already outlined. (Fig. 9.)

Following the operation the patient was referred back to his dentist for construction of dentures. (Fig. 10.)

CASE 2.—Patient J. P. B., aged twenty-five years, had a protrusion of the maxillary alveolar process with marked overbite of the maxillary anterior teeth. The incisors inclined forward at about a 45 degree angle (Figs. 11 and 12).

The maxillary teeth were removed in three stages, January 30, February 4, and February 8, 1934. On February 4, 1934, I extracted the two central incisors, right and left lateral incisors, right and left cuspids, and performed an alveolectomy and constructed a ridge.

The patient made a good recovery and was ready for artificial dentures on February 25, 1935. On November 4, 1935, he reported that he was wearing the denture successfully (Fig. 13).

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## USE OF VINYL ETHER AS A DENTAL ANESTHETIC\*

JOHN H. GUNTER, D.D.S., M.D., EDWARD W. BEACH, M.D., AND  
JOHN P. LOOBY, D.D.S., PHILADELPHIA, PA.

CONSIDERABLE interest in divinyl ether as a general anesthetic has developed during the last five years. In 1930, Leake<sup>1</sup> and Chen predicted that an ether of this type might show properties that would approach the ideal for inhalation anesthesia. Enthusiasm over the potentialities of this preparation has been increasing.

Because of the rôle the dental profession played in the early history of general anesthetics, our interest has become traditional with this branch of the healing art. It is this traditional interest in anesthesia that prompted us to give divinyl ether a thorough trial.

It was only after the publication of the results of extensive research on this anesthetic and after careful clinical study that it was tried by us in the field of minor oral surgery, including the extraction of teeth. The salient features of its usefulness will be described in this paper.

The trend of the profession in recent years has been distinctly toward real "surgical" anesthesia in the cases in which general anesthesia has been indicated. To bring the patient to this state has made necessary a radical change in technic from the old method which meant simply to "knock out" the patient and "pull the tooth."

In a high percentage of cases this procedure was, to put it bluntly, asphyxia and not anesthesia. Therefore the danger from resultant strain on the patient from the rushed physiologic action was much greater than when the anesthesia was given in a smooth, acceptable manner, allowing the patient to react normally. We believe that divinyl ether is a step in the direction of more pleasant anesthetics.

Pure divinyl ether is a clear, colorless liquid, with a specific gravity of 0.77 at 20° C., and a boiling point of 28.3° C. It has a characteristic odor which is often noticed by the anesthetist but rarely seems to cause the patient any discomfort. It is about as expensive to use as nitrous oxide and oxygen but does not require the extensive apparatus to handle it.

It is as explosive and inflammable as ethyl ether but more volatile. The divinyl ether that has been prepared for anesthesia contains two additional ingredients. The first of these is a small amount of absolute alcohol which prevents too rapid evaporation. The second substance is to prevent decomposition. It is this mixture which we have used in our work.

Two methods of administration have been used. The first being the open drop, which has brought gratifying results, especially in the cases of young children. The second is the substitution of vinyl ether for ethyl ether in the

\*From the Department of Maxillofacial Surgery, School of Dentistry, University of Pennsylvania.

Read before the Sectional Meeting of the International Association for Dental Research, Academy of Stomatology, Philadelphia, May 19, 1936.

special container attached to the gas apparatus. The interesting features of both methods are: (1) a quick onset of the surgical stage of anesthesia; (2) complete relaxation of the patient as with ethyl ether; and (3) quick recovery after discontinuing the administration of the anesthetic. Nausea did not occur more frequently in connection with the divinyl ether than with nitrous oxide and oxygen.

*The Open Drop Method.*—A piece of gauze approximately 9 inches by 5 inches and 3 layers thick is placed over the patient's nose and mouth. Another such pad is placed on the table next to the anesthetist in the event that doubling the thickness of the gauze pad during the administration of the anesthetic becomes necessary. A bottle of divinyl ether with a special dropper is kept ready. The mouth prop, the throat pack, and the instruments to be used in the operation should be conveniently arranged for immediate use, as lost motion should be avoided especially in short operations. The room should be quiet and the light used for operating turned off.

1. Seat the patient properly in the chair as would be desirable for the inhalation of nitrous oxide and oxygen. The back of the chair is then tilted so that the patient is in a semirecumbent position. This is an important factor, because it will allow the liquid to drop from the bottle so as to strike the gauze from a vertical position. (Note the application as described in point four.)

2. The anesthetist takes a position behind the patient and a little to the left. The patient is instructed to raise his left arm and hold it vertically. A suitable side gag is placed in position, and the patient's mouth and nose are loosely covered with the gauze pad.

3. Before the divinyl ether is dropped upon the gauze, the bottle containing it is held in the palm of the hand in such a manner that the heat from the hand will warm it and aid in developing a faster flow during the first few seconds of administration. This is very important.

4. The divinyl ether is applied drop by drop over the gauze and the area over the nostrils is well saturated. Then a few drops are placed over that portion of the gauze covering the mouth. The end of the dropper is never held too far from the gauze to insure a quick, even saturation.

5. The patient is watched carefully for signs of muscle relaxation. This first appears when the raised arm falls to the horizontal position. Careful watch of the respiration is kept because a slight change in its depth has always been observed to accompany muscle relaxation. A slight flushing of the skin is apparent as the anesthetic begins to take effect. This continues during, and for a short time after, the operation. The rise in color of the skin is especially noticeable in individuals with a light complexion.

6. When the skeletal muscles are relaxed as shown by the lowering of the arm, the patient is sufficiently anesthetized for simple extractions. This will permit operating for a period of one or two minutes. If the operation is to be continued for a longer period, the gauze which covers the mouth may be folded back over the nose and the administration continued, permitting a longer period of surgical anesthesia.

7. The packing of the throat may be conveniently done as soon as muscle relaxation takes place. Throat packs will not be discussed in this paper. We

find, however, in cases of simple extraction in children that a fairly good-sized piece of cotton serves the purpose of throat pack very well.

8. As soon as the operation is completed, the cotton pack already in the mouth is moved over the site of extraction, thus controlling the flow of blood. This method also affords a better passageway after extraction for air to pass through the mouth. The gauze is now removed from the nose, and the patient is allowed to recover consciousness.

#### VINYL ETHER COMBINED WITH NITROUS OXIDE

We have found it most agreeable to the patient to start the anesthesia by giving nitrous oxide and oxygen first, then adding the ether to the mixture. The vinyl ether is previously placed in the ether container of the gas machine.

1. The patient is placed in the chair as for the regular administration of nitrous oxide and oxygen. He is then asked to clasp his hands together. Preparations for the operation are completed.

2. The mouth is then propped; the nosepiece of the gas machine is placed over the patient's nose with the nitrous oxide mixture flowing. As the patient begins to breathe through the nose and to exhale, a moist towel of agreeable temperature is placed over the mouth. This is done to prevent the patient from breathing through his mouth.

3. The patient is first brought to the level of light surgical anesthesia. The gas machine is so regulated that the necessary amount of gases is allowed to flow over the vinyl ether in the container, and the desired degree of relaxation is obtained. This flow of mixture may vary according to the patient, from one-quarter to all of the gases flowing over the ether. From this stage on, it is a matter of the depth of the anesthesia desired and the interpretation of the symptoms by the anesthetist. When the patient has reached the desired level of surgical anesthesia, the throat may then be packed and the operation begun.

4. The mixture of oxygen used in this type of anesthesia may vary from 5 to 18 or 20 per cent, according to the patient. In using this method of anesthesia all the symptoms of deep surgical relaxation are rapidly obtained. This is of great value in prolonged operations which may call for increased time or more extensive surgery in a completely relaxed patient, without any symptom of anoxemia.

5. As soon as the operation is completed, the patient may be given straight oxygen and hasten the recovery of consciousness. Recovery from this type of anesthesia is slower than the recovery following the open drop method. This may perhaps be the result of greater depth of anesthesia.

In summarizing, it may be said that divinyl ether has a place as a general anesthetic in dental surgery somewhere between nitrous oxide and ethyl ether. Like ethyl ether, divinyl ether is inflammable and explosive. Because of its apparent potency as an anesthetic, divinyl ether must be administered with care to avoid too much and too rapid concentration. Its practical use should be guarded by the same rules which govern the use of other inhalation anesthetics in common use, namely, nitrous oxide and oxygen, ethyl chloride, and ethyl ether. We believe that, in the hands of dental surgeons who are familiar with general anesthetics and are acquainted with their use, satisfactory results are assured.

Divinyl ether (vinethene\*) has proved its usefulness in minor surgical operations about the mouth. We believe that it can be safely employed in dental surgery by any one familiar with the necessary anesthetics, namely, nitrous oxide and oxygen, ethyl chloride, or ethyl ether.

The data gathered from the work done at the School of Dentistry of the University of Pennsylvania follow:

Total number of cases, 243.  
 Average age of patients, 12.4 years.  
 Average induction time, 1.4 minutes.  
 Average recovery time, 1.69 minutes.  
 Average time of operation, 2.8 minutes.  
 Nausea was present in 20 cases, 8.2 per cent.†  
 Abnormal excitement present in 15 cases, 6.2 per cent.  
 Average number of teeth extracted, 1.6.

The records from the work done at the Graduate Hospital of the University of Pennsylvania showed:

Total number of cases, 162.  
 Average age of patients, 35 years.  
 Average number of teeth extracted per case, 3.5.

Anesthesia:

Excellent	17 cases
Good	54 cases
Fair	8 cases
Poor	10 cases
Excitement in	15 cases

Postoperative recovery:

Quiet	34 cases
Noisy	5 cases
Congested	3 cases
Nausea	1 case
Excessive saliva	7 cases

Induction period	1 minute	57 seconds
Maintenance period	1 minute	17 seconds
Recovery period	2 minutes	45 seconds

Fifty per cent of the Graduate Hospital patients were colored.

Advantages of vinyl ether:

1. Ease of administration.
2. Rapid onset of anesthesia.
3. Rapid recovery.
4. Completeness of relaxation when necessary.

\*The Laboratory of Pure Research of Merck & Company, Rahway, N. J., supplies the divinyl ether in the form described under the trade name of vinethene.

†Fourteen of these were in the first 75 cases. We might account for this by our lack of acquaintance with the drug. Nausea seems under ordinary conditions to be exceedingly rare when this agent is used for general anesthesia. Five of the cases are listed as slight nausea.

5. Rareness of nausea or postoperative discomfort.
6. Absence of relaxed bladder.
7. Nominal cost. No apparatus for administration required.

Disadvantages of vinyl ether:

1. Increased flow of saliva.
2. Unstable when exposed to light and air.
3. Supply of anesthetic must be kept fresh.
4. Concentration of dose must be carefully regulated.

Indications for vinyl ether:

1. Children's extractions.
2. As an adjunct to basal anesthetics.
3. When a complete ether relaxation is desired.
4. When work is to be done in the home.

Contraindications of vinyl ether:

1. Patients who show changes in the liver.
2. Patients who have disease of the respiratory tract and would not be desirable for an inhalation anesthesia.
3. Vinyl ether should not be used as an adjunct to a basal anesthetic until the basal anesthetic has had time to take full effect.

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## Department of Orthodontic Abstracts and Reviews

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• Edited by  
DR. EGON NEUSTADT, NEW YORK CITY

All communications concerning further information about abstracted material and the acceptance of articles or books for consideration in this department should be addressed to Dr. Egon Neustadt, 133 East Fifty-Eighth Street, New York City.

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### **Paying Through the Teeth.** By Bissell B. Palmer, New York, Vanguard Press.

The world has preachers of many gospels of reform, but the disciples who have the courage to bring the stories of dental quackery and misinformation to the attention of the public have been few and intermittent. It is with much pride and with great pleasure that we congratulate the author for writing, and the publishers for printing, a truthful and scourging arraignment of the best-known dental and allied nostrums.

From a mild beginning about "Teeth and Health" the author wades through the various "cure-alls" and "help-alls" of well-advertised oral health aids, meticulously and assiduously comparing the asininity of their advertised claims with their true worth. He turns the light of truth on the assumptions and presumption of the many pretenses of the manufacturers to wheedle dollars out of the pockets of an ever gullible public to the material advantage of the seller with utter disregard of the consumer.

Without much fanfare or great ado, he calmly proceeds to prove the danger of the radio and the press which are subsidized by moneys provided by advertising, stressing the danger of such procedure. He shows the peril of innuendoes of both the spoken and the written word, pointing out that the law might be effective if it honestly tried to protect the public. He advocates putting teeth in the Pure Food and Drug Act, but shows the influence being brought to bear in political circles which have prevented such enactment. A sad commentary on American politics but an enlightening résumé for those unfamiliar with the situation. The remedy is suggested for those who are willing to take up the cudgels.

As the jacket of the book proclaims, "This book is another publication that names names." It runs the entire gamut of the best known and most widely used dental products sold directly to the public, analyzing their contents, their claims, and giving the name of the manufacturer, then proceeding honestly to evaluate each. When he has finished there is little left to recommend them except a tremendous profit left in the pockets of the sponsors. The proofs are submitted by accredited agencies and records of the United States Government suits. The moral would be, read the label for contents and claims, compare them with the spoken or written advertising, and judge the value by the differences among them. In the reviewer's opinion there would be nothing to recom-

mend them. So to quote E. E. Calkins in the August, 1935, *Current History*: "If goods were sold by fact and logic, Consumer's Research would be larger than Standard Oil."

The reviewer agrees with the author that those dentifrices which have the approval of the Council on Dental Therapeutics should have the support of the public and should be recommended by the dentist because of the honesty of intent behind the product and the advertising. The fact that the product has been placed on the list and granted the seal of Accepted Dental Remedies should be recognized by the consumers. It should not, however, be the occasion, as has been evidenced by one tooth paste manufacturer recently, for the advertising of the seal with the product as an incident in the copy.

The long list of misbranded dental nostrums published is valuable. The chewing gum industry's effort for scientific recognition is a true and illuminating exposé.

This book, which shows great care in preparation, is a fine bit of writing, is a valuable addition to the list of those along the same line in other fields, and should be read and digested by both the lay-public and the professions. It has a fine index, a voluminous table of contents, and is carefully cross indexed throughout the text at the bottom of many pages so that reference to other portions of the book is easy.

Again we congratulate the author and his publishers for their courage, because the light has been turned on the dark spots of everyday dental remedies.

Leonard Kohn.

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**Tijdschrift Voor Tandheelkunde. Jubileum, Ch. F. L. Nord, 1936.** Utrecht, G. J. & D. Tholen.

The leading Hollandish dental journal, *Tijdschrift Voor Tandheelkunde*, has on the occasion of the twenty-fifth dental anniversary of Ch. F. L. Nord, its editor-in-chief, arranged a special edition dedicated to him. This marks the fifteenth year of his editorship of this periodical, which on account of its progressiveness and high ethical standards is enjoying the highest reputation in the dental profession of Europe. Nord has for the past four years been the secretary of the Federation Dentaire Internationale, to the organization and success of which he has contributed much. Harold Chapman says about him: "The name of Nord is synonymous with Truth and Progress in Dentistry."

Special contributions for this Jubilee issue have been received from outstanding men in many countries:

Louis Frank, "The Secretion of Saliva" (Speekselafscheiding).

Viggo Valdemar Julius Andresen, "Treatment of Impacted Canines by Means of Functional Therapy" (Die Functions-Kieferorthopadische Behandlung retinierter Eckzähne).

Harold Chapman, "Truth and Progress in Orthodontics."

Professor Dr. A. Cieszynski, "The Development and the Morphogenesis of the Teeth From the Static Point of View" (Die Entwicklung und Formgestaltung der Zähne vom Statischen Gesichtspunkte).

Eric Wilfred Fish, "Impermeability of the Calcified Collagenous Matrix of Bone, Dentine and Cementum."

B. Gottlieb, "Deposition of Cement in Its Relationship to Root Canal Therapy" (Zementapposition und Wurzelbehandlungserfolg).

Ernst Haderup, "Traumatic Occlusion and Parodontosis."

Professor Dr. Gustav Korkhaus, "Tooth Eruption and Jaw Development" (Zahndurchbruch und Kieferentwicklung).

Dr. Maurice Roy, "The Grinding of Teeth at Night Is Not a Cause of Pyorrhea" (Le grincement nocturne des dents n'est pas une cause de parodontose).

Dr. Hendrik Salamon, "Retention or Not Retention—That Is the Question."

Dr. A. Martin Schwarz, "Some Advantages of Removable Plates in Orthodontic Treatment" (Einige Vorteile der abnehmbaren Platten in der Kieferorthopädie).

Professor Dr. Paul W. Simon, "Wipla's Stainless Steel Appliances Without Soldering or Welding" (Die orthodontische Wipla-Faltapparatur ohne Lötung und Schweissung).

George B. Winter, "Progress and Achievement."

There are altogether sixty-five contributions from various authors and countries, representing an interesting cross-section of modern ideas on dentistry, particularly orthodontia. Full page photographic reproductions of the authors furnish interesting side lights to the names of those men whom we know but have never seen.

*E. N.*

## The Forum

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Articles for this department should be sent to Dr. William R. Humphrey,  
1232 Republic Bldg., Denver, Colo.

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### Continuing the Discussion in Regard to Early Treatment

I should like to submit for further discussion a case taken from a paper, "Maintenance of Space After Extraction and Treatment of Malocclusion of the Deciduous Teeth as a Preventive Measure,"\* which I read at the Chicago Midwinter Clinic, January, 1930.

Fig. 1.

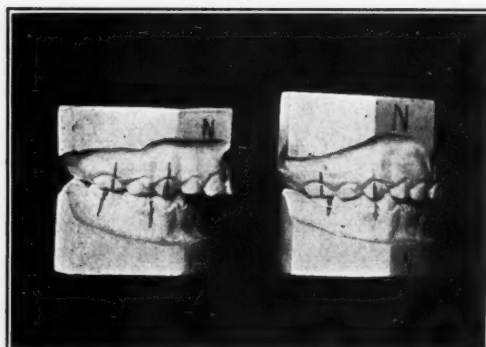


Fig. 2.

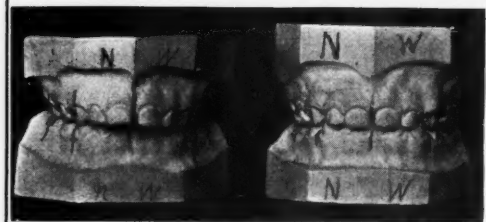


Fig. 3.

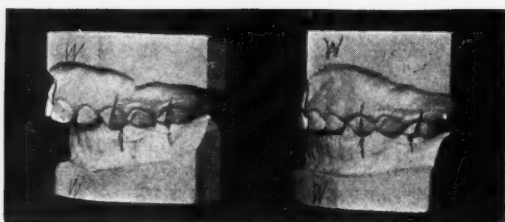


Fig. 4.

The patient was treated at the age of three years and ten months. Although further treatment in the permanent dentition was required, the result of treatment of the deciduous teeth as shown justifies the attempt. The improvement, both in facial contour and in the health of the patient, is apparent in the illustration of the face, Fig. 5. This improvement is largely due to the restoration of the normal masticatory function of the deciduous dentition.

I believe the key to the whole situation in regard to the treatment of the deciduous teeth depends upon whether or not the etiologic factors can be removed and whether or not the treatment can be accomplished with sufficient

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\*J. A. D. A., November, 1930.

speed to enable the patient to have use of the corrected denture before resorption of the deciduous tooth roots takes place.

I cannot believe that the statement that no malocclusion of the deciduous teeth should be treated can stand against such evidence as submitted in cases of this kind. The literature is quite well filled with such examples.

The treatment of the case as described in 1930 is as follows: Distocclusion case in a girl, aged three years and ten months. The cause was thumb-sucking. Fig. 1 shows the occlusion before treatment, on the left, and after treatment, on the right. The treatment consisted of expanding the maxillary arch by means of a 0.030 round arch attached to the second deciduous molars by



Fig. 5.

round buccal tubes, and to the deciduous cuspids by the Ketcham hook. The anterior portion of the arch was bent into a cupid's bow and gradually enlarged to the shape shown in the casts on the right in Fig. 2. The model on the left in Fig. 2 shows the condition before treatment. No appliance was used on the mandibular teeth, but the child was instructed to place the teeth in positions of mechanical advantage and to masticate in that position, the treatment suggested by A. P. Rogers of Boston. Figs. 3 and 4 show other views of the models. The models on the right of each illustration show the result of eleven months' treatment. Fig. 5 shows the face; left, before treatment, and right, two and one-half years after treatment.

Wm. R. Humphrey.

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## Editorial

### Politics and the American College of Dentists

THE decoration idea is not new; it may be seen everywhere. For instance, the plumes and tassels of an Ethiopian tribal chief, the swords and saber rattling of the *generalissimos* and *soldados*. It may be observed in the splendor of any Knights of So-and-So organization—the regalia and the passwords—hundreds of evidences wherever human beings gather; and so it is, since antiquity, that degrees and honorary titles have been bestowed upon men and women who, by rendering signal service to civilization or for outstanding achievements, have done something worthy of special note. This custom was possibly started with the handing of a piece of cloth from Rahab's window at the siege of Jericho, to show the attackers of that historic city that she had

rendered a signal service to the spies of the attacking armies. The early Greeks gave to the winners in the Olympic games the simple decoration of a crown of olive leaves—something that, in itself, meant little so far as intrinsic worth was concerned, but something to a youth winning it, that transcended all other values.

Centuries ago there was formed the organization of the Royal College of Surgeons—with its Fellows of the Royal College of Surgeons. Men won this degree by a discovery in the field of surgery that benefited mankind. The same was true of F.R.C.P.—Fellow of the Royal College of Physicians; in France, Germany, Belgium, Switzerland, Italy, Spain—in fact, all civilized centers. And so on, *ad infinitum*.

Not to be outdone, the founders of the American College of Dentists, for a fellowship of dentistry, apparently had a sublime vision—one that dentistry surely needed. It was hoped that this reward would stimulate research and that, as a result, scholars in the dental field would be developed to lead dentistry into a promised land where science and not commercialism would rule. Alas for such decrees! According to some of the original founders of this fellowship, we see a panorama:—a learned Commission on Journalism, like a crazy man striking wildly here, castigating and denouncing there; apparently to gratify the peacock impulse—to strut with gaudy plumage before a yapping barnyard audience. We see a “reform complex” in operation, a crusading zeal in this crowd for destructive purposes of impossible idealism. An old-time politician has said, “There is nothing so dangerous as a scheme carefully concealed under the cloak of altruism.” But, to get to the question in hand:

Some years ago, the American College of Dentists, it being a fellowship organization, constituting a small fraction of 1 per cent of the dental profession, appointed a group of intellectually muscle-bound “brain trusters,” which was called the Commission on Journalism, which from year to year made various reports pertaining to dental journalism in America. As a tail wind to these reports, there was launched a barrage of propaganda, the purpose of which was plainly to present a united front of opposition to all independent dental journals, regardless of “creed, color, or previous condition of servitude.” To accomplish this purpose, obviously organized propaganda was sent to editors of official dental journals, denouncing all independent journals as “wicked, naughty and even plebeian in character.” Syndicated propaganda from great oracles of this Holy Alliance have been published in the state journals; myriads of reprints have been broadcast from these sources, all for the obvious purpose of spreading propaganda and discrediting all dental journals which are independently owned and independent of the profession in character.

In one of its former publications the Commission made a short report in regard to the INTERNATIONAL JOURNAL OF ORTHODONTIA AND ORAL SURGERY which was about as inaccurate in the information conveyed to the fellowship as the fellowship should have expected it to be.

The original Commission on Journalism has, in all probability, wearied of its own tiresome propaganda and has appointed a new Commission of men

of the F.A.C.D. who, it is presumed, will follow orders in the purity crusade of this sacrificing band. Of interest to orthodontists throughout the world, the latest move pertaining to this propaganda is evidenced by a series of letters sent out requesting information in regard to orthodontic publication in order to enable this group or commission again to make a report before the American College of Dentists in San Francisco pertaining to orthodontic publication. The American College of Dentists, in financing this move and shedding crocodile tears over orthodontic publication, at this time, as an organization and directing its Commission on Journalism to make a report, strikes the average orthodontist much as the child is struck by the legend of Red Riding Hood, "Grandma, what big teeth you have!"

The business of making a survey or report of orthodontic publication is that of the orthodontic organizations which are interested in the subject, and not the American College of Dentists, whose own members when interviewed indicate that they have no interest whatsoever in such a survey and do not even know that one is being made or considered. At such time as official organizations of orthodontists desire a report on orthodontic publication, the *INTERNATIONAL JOURNAL OF ORTHODONTIA AND ORAL SURGERY*, with its background of twenty-two years of publishing orthodontic manuscript, will be glad to contribute its wholehearted cooperation; and its editors will provide all information possible to make such a report for orthodontists of some service and value to the specialty.

In a recent communication, apparently sent out to the membership, the president of the American College of Dentists says, "We are convinced that there is some uncertainty in the minds of many of our fellows in regard to the proper functions of the college." It might have been equally appropriate for the president to add to the above assertion that there is also considerable uncertainty in the minds of thousands of undecorated dentists practicing in America as to what are the purposes of the American College of Dentists—other than appointing as High-Priests-of-all-things-in-Dental-Journalism, and to become active in political assignments.

It is time the American College of Dentists itself does something about its most colossal folly, the Commission on Journalism, before it is too late, before the traditional calf has been given all the rope that leads to the supreme sacrifice, and before it has been clowned out of its entire caste. When an umpire of a baseball game enters the business of umpiring, he expects an avalanche of pop bottles if he makes an unfair decision—that's part of the umpiring business! He gets paid for dodging pop bottles. The American College of Dentists should also stay out of the umpiring business, as its original founders, according to their own statements, expected it to do, and devote its time to conferring honor where honor is due, and while there is left within its body some honor to confer—otherwise its decoration will soon mean no more or no less than a turkey feather stuck through the nose of an Ethiopian chieftain while he dances in high glee seeking witches to burn at the stake on the altar of religious fanaticism.

—H. C. P.

## News and Notes

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### **Texas State Dental Society**

The Fifty-Seventh Annual Meeting of the Texas State Dental Society will be held in Dallas, August 31 to September 4, in conjunction with the Texas Centennial Exposition. Postgraduate courses will be offered in the four major branches of dentistry by twelve nationally known clinicians. For information, address Dr. J. G. Fife, secretary of the Texas State Dental Society, Medical Arts Building, Dallas, Texas.

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### **American Society for the Promotion of Dentistry for Children**

The annual meeting of the American Society for the Promotion of Dentistry for Children will be held in the Francis Hotel, San Francisco, Calif., on July 13 and 14, 1936. Interesting and helpful papers, table clinics, and practical demonstrations will be given covering all phases of dentistry for children. A round table luncheon will be held on Monday, July 13, at 12:30. All sessions will be held at the Francis Hotel, and every member of the American Dental Association and the Canadian Dental Association will be most welcome.

WALTER T. MCFALL, President.

JOHN C. BRAUER, Secretary.

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### **American Dental Assistants Association**

The twelfth annual meeting of the American Dental Assistants Association will be held in San Francisco, Calif., July 13 to 17, 1936. Headquarters will be at the Hotel Whitcomb. For further information please address

LUCILE S. HODGE, General Secretary,  
401 Medical Arts Building,  
Knoxville, Tenn.

### **British Empire Dental Meeting**

The British Empire Dental Meeting will be held in London during the last week of July. A large delegation of Canadian dentists will be in attendance and will leave Montreal on July 10. Dr. Fred J. Conboy of 86 Bloor St. W., Toronto, Ontario, is chairman of the Arrangements Committee.

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### **Postgraduate Course in Periodontia at New York University College of Dentistry**

The New York University College of Dentistry will hold its third annual postgraduate course in periodontia for two weeks, full day; or for four weeks, mornings only, beginning July 6, 1936. Courses are limited to fifteen men.

The course will include etiology, diagnosis, and treatment of periodontal disease. Various technics of pocket eradication will be considered and conservative treatment stressed. Vincent's infection; diagnosis of types of bone resorption; mouth manifestations of systemic disease; periodontal foci of infection; toothbrushing; instrumentation; balancing of occlusion. Taught by lectures and clinical work, each student treating several cases.

Instruction by Drs. Samuel Charles Miller, Sidney Sorrin, J. Lewis Blass, and the entire periodontia faculty.

For information and application, address Periodontia Department, New York University College of Dentistry, 209 East 23rd Street, New York, N. Y.

SAMUEL CHARLES MILLER,  
Associate Professor of Periodontia.

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### **Ninth International Dental Congress of the F. D. I. in Vienna**

In Vienna, Austria, from August 2-8 inclusive, the Ninth International Dental Congress of the Federation Dentaire Internationale will be held.

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### **American Association of Women Dentists**

The American Association of Women Dentists will meet at San Francisco, July 13 to 17.

DR. VIRGINIA TREMBLY,  
317 Burns Building,  
Colorado Springs, Colo.

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### **Omicron Kappa Upsilon**

The members of Omicron Kappa Upsilon will meet for a good fellowship luncheon at the St. Francis Hotel, San Francisco, during the meeting of the American Dental Association to be held in that city July 13-17, 1936.

Dr. Fred T. West of 2595 Mission Street, San Francisco, is chairman of the local committee in charge of the luncheon.

ABRAM HOFFMAN,  
Supreme Secretary-Treasurer,  
311 East Chicago Avenue,  
Chicago, Illinois.

### American Dental Association

The Seventy-Eighth Annual Meeting of the American Dental Association will be held at San Francisco, California, July 13 to 17, inclusive.

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### Denver Summer Seminar Course in Orthodontia

There will be a summer seminar for the study of orthodontia to be held in Denver, at the University of Colorado School of Medicine, on July 27 to August 8, dedicated to the late Dr. Albert H. Ketcham.

It was long the plan of Dr. Ketcham to promote the study of orthodontics through discussion groups which would bring his friends to Denver and the Rocky Mountains. The summer seminar has been organized by a group of his friends and associates in the hope that it may realize in some measure the wish which ill health prevented him from carrying on.

Records, casts, and radiographs accumulated carefully and methodically throughout Dr. Ketcham's thirty-five years of orthodontic practice will be available for use as study material. Because of his long association with orthodontia and his unremitting efforts to improve his methods, Dr. Ketcham's records present an exceptional picture of progress in orthodontic treatment and offer an excellent opportunity for comparison of different methods.

It is hoped that the seminar plan will make possible a careful analysis of these records so that information compiled may be presented at subsequent meetings.

With one exception, leaders for the first summer seminar are Denver men. This arrangement seemed best because of the considerable task of organizing the program and making necessary arrangements.

*Herman Becks*, Dr. Med. et Med. Dent., D.D.S., F.A.C.D., Assistant Professor of Dental Medicine, University of California and George Williams Hooper Foundation for medical Research. Dr. Becks is well known for his work on bone pathology and root resorption.

*William R. Humphrey*, D.D.S., for seventeen years an associate of Dr. Ketcham. Dr. Humphrey is well qualified to present Dr. Ketcham's cases as well as his own material on diagnosis and treatment.

*A. B. Brusse*, D.D.S., and *J. Lyndon Carman*, D.D.S., have pioneered in research on chrome alloy, a technic for spot welding and its application to orthodontics.

*Charles M. Waldo*, A.B., D.D.S., M.S., Fellow in Orthodontia, The Child Research Council, University of Colorado School of Medicine; worked with Dr. Ketcham during several years upon radiographic problems of orthodontic research and practice.

The seminar will be limited to orthodontists who are members in good standing of the American Society of Orthodontists, or whose applications are filed. It will be conducted on a non-profit basis.

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### Montreal Twelfth Annual Fall Clinic

Arrangements for the Twelfth Annual Fall Clinic at the Mount Royal Hotel, October 14, 15, 16, under the auspices of the Montreal Dental Club, are nearing completion. A provisional program is given below.

Dr. C. H. Franzwa, New York City: "Partial Denture Construction."

Detroit Clinic Club: "Amalgam Restorations."

Dr. W. St. C. Anderson: "Metallurgy of Dental Amalgams."

Dr. F. E. Koepel: "Present Status of Dental Amalgams."

Dr. J. G. Coggan: "Manipulation and Insertion of Dental Amalgams."

Dr. Thos. E. Thompson: "Cavity Preparation and Matrix."

Dr. S. E. Riesner, New York City: "The Temporomandibular Joint."

Dr. G. C. Peck, Glens Falls, N. Y.: "Gold Inlays."

Dr. G. W. Clapp, New York City: "State Dentistry and Dental Health Insurance."

Symposium on "Oral Surgery, Anesthesia, Periodontia, and Orthodontia."

Series of Chair Clinics in local offices.

Membership reservations now being accepted by the treasurer, Dr. F. A. Edward, 910 Medical Arts Building, Montreal, Canada.

The Canadian Dental Association will this year hold its meeting in Montreal in conjunction with the Twelfth Annual Fall Clinic.

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#### Notes of Interest

Dr. William S. Gray announces the opening of his office, 803 Medical Arts Building, Nashville, Tenn. Practice limited to orthodontia.

Dr. W. Glenn Phillips, orthodontist, announces the removal of his office to 407-8 Medical Arts Building, Jacksonville, Fla.

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#### Erratum

In the editorial "The American Society of Orthodontists" which appeared in the June issue of the JOURNAL, on page 647 the list of officers should include Dr. B. G. DeVries of Minneapolis, Minnesota, as the new member of the American Board of Orthodontia.

